POWER

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Two Ways of Telling a Story

CRABS walk backward, the Chinese read backward and some men tell stories "wrong end to." Others begin in the middle and ramble toward both ends simultaneously.

A few days ago such a man rushed up to the chief engineer's desk and blurted: "It broke off and I can't drill it out. I only pulled easy on it, and the dingbusted thing let go and nearly spilled me. Anyway the spool was cracked and——".

The chief was working on an estimate for some new piping. Even had the story been logically presented, he would not have gathered the drift at once. With what patience he could command, he requested that the story be retold, starting at the beginning. Then the man began in the middle. "Why the spool on the left hand—no the right hand I guess it is,—piston rod broke——."

"I see," the chief interrupted, "You have been working on a pump. What one?" And by shooting in a question each time the story strayed, he at length learned what had happened.

Lack of logic, lack of tact, lack of appreciation of the other fellow's state of mind are deficiencies which irritate in any sort of interview.

A short time later another repair man walked up to the chief's desk. He waited until the chief came to a stopping place and turned for the story. Then: "I have been working over in building K basement on that twin vertical engine that runs the centrifugal pump. On the side next to the wall the crankpin appears to be loose."

He obtained attention, located his work and then explained his trouble. It is easy to listen to a story told so logically, so simply and directly. The man who can tell his story in that way generally finds the door open for him.

Take your own case. When you go up to the manager's office to talk matters over, have you prepared your story? Are you satisfied that it is logical? Have you gathered all the necessary data? Have you appreciated his viewpoint? If you have done these things, you will be much more likely to succeed. You will be more welcome next time.

Contributed by WILLIAM E. DIXON

New Studebaker Boiler Plant at South Bend

Modern Boiler Plant Supplying Steam for the New Factory Unit Erected To Manufacture the Studebaker Light-Six Automobile. The Plant Has an Initial Capacity of 4,160 hp. and Is Well Equipped with Labor-Saving Devices and Instruments To Indicate the Operation

THE latest addition to the Studebaker-plant system is the new fifteen-million-dollar unit at South Bend, Ind., now practically completed, for the building of the Studebaker light-six car. It consists of five buildings of mammoth proportions laid out and equipped for efficient manufacture. They will include assembly and sub-assembly buildings, both four-story structures, a forge shop, machine shop and press shop accommodating the stamping department. This group of buildings has a floor space of 1,206,800 sq.ft. They are served by 153 miles of electric wiring, 6,640 ft. of water mains, 6,169 ft. of sewer lines and 3,081 ft. of tunnels for carrying steam, water and electrical lines to and between the various buildings. They are equipped with 12 freight elevators, 4 passenger elevators and 34 traveling cranes.

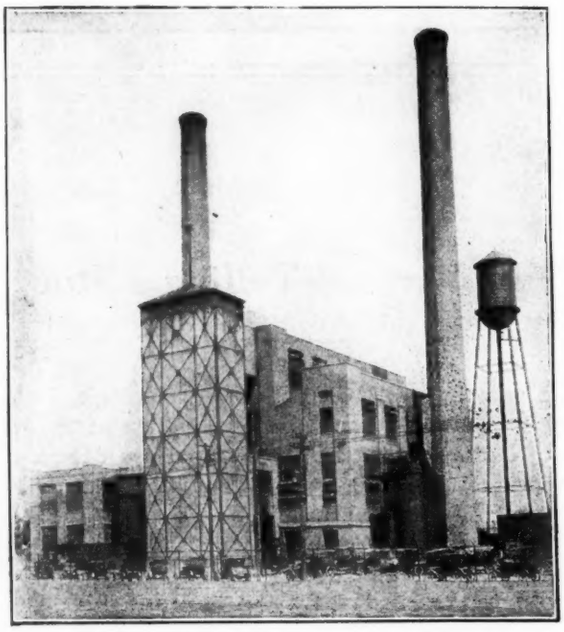

FIG. 1. EXTERIOR OF NEW STUDEBAKER BOILER HOUSE

To serve this factory unit is the purpose of the new boiler plant. Steam is supplied to the forging hammers, annealing ovens and other mechanical equipment. It is also utilized to pump water and oil to the various departments, as well as to heat the buildings. Steam is generated at 175 lb. pressure and superheated 75 deg., although it is utilized for the most part at 125 lb. pressure.

During the heating season the exhaust from the hammers is sufficient for the heating, excepting in the coldest weather, when it is supplemented with live steam. In the two four-story buildings there is both direct and indirect heating, and direct radiation only in the other buildings. The heating is done by a vacuum system bringing back the returns to the boiler house. In the indirect system the fans and the pumps for circulating the water to wash the air are motor-driven. These, in brief, are the present services of the boiler house. The heating load is estimated at 2,355 boiler-horsepower and the demand for industrial steam at 3,480 boiler-horsepower. Compressed air at 100 and at 50 lb. pressure is supplied the shops by four synchronous-motor-driven compressors using purchased current, but plans for the future call for a complete generating plant to care for all the South Bend properties and the provision of a spray pond to conserve cooling water.

Fig. 1 is an exterior view of the boiler house, with the coal-conveyor tower in the foreground. On either side are water-softening plants, and at the extreme left is the engineer's office. Back of this is the compressor room. The boiler house is of neat, substantial brick construction, well provided with glass area for light and ventilation. Fig. 2 shows that the boilers are placed four on each side of a central firing aisle. In the present building there is room for two additional boilers on either side, and future plans call for an extension, when it is needed, that will house eight additional boilers. The present building, then, is planned for twelve 520-hp. water-tube boilers having an aggregate capacity of 6,240 horsepower.

As previously stated, the operating pressure is 175 lb. gage, and the superheat 75 deg. Each boiler is equipped with a six-retort underfeed stoker, chain-driven from a lineshaft on either side in the basement. There are two vertical engines on each shaft, one acting as a reserve unit. Forced draft is supplied by two turbine-driven fans on either side, both connected to a common duct running the full length of the firing aisle. The duct is dampered so that a division of the service may be made between the two fans as desired.

Reference to Fig. 5, a sectional elevation through the boiler room, will show that the furnace has been made large to burn the Indiana coal used in the plant. The bottom of the front tube header is twelve feet above the floor. The volume of the furnace is approximately 900 cu.ft. As the equivalent grate area of each underfeed stoker is practically 100 sq.ft., the furnace volume per square foot of grate area reduces to 9 cu.ft. Assuming that 50 lb. of coal will be burned normally per square foot of grate per hour, the furnace volume becomes 0.18 cu.ft. per pound of coal burned. This allowance is no more than is needed for the high-volatile coals of the Central West, particularly when the boilers are to be operated above rating as is the intention at this plant.

An innovation has been made in the baffling, which is of the horizontal type. The lower row of tile originally placed on the third row of tubes has been raised to the eleventh row and the opening at the top baffle changed end for end, the final passage of gases being along the drum to the outlet. With this arrangement benefit is obtained of the direct radiation from the fire.

In Fig. 6 are shown a plan view and front elevation of the smoke flue, or breaching, which is made of steel covered on the outside, and it is of tapering section as it proceeds toward the stack. It will be seen that there is a breaching on either side, serving each row of boilers and discharging into a brick stack 10 ft. in diameter at the top and 200 ft. high. The breaching is rectangular in section and at the stack has an opening of 81 sq.ft. as compared to 78 sq.ft. for the stack damper as well. There is a flow meter for each unit, with the indicating dial on the boiler front and the integrating and recording meter in the chief engineer's office. Draft gages show the draft at the uptake and over the fires. The boiler equipment also includes the usual pressure gages, water columns, return valves, mechanical soot blowers, etc.

The plant has two sources of boiler feed water—deep wells on the premises and the city supply, which

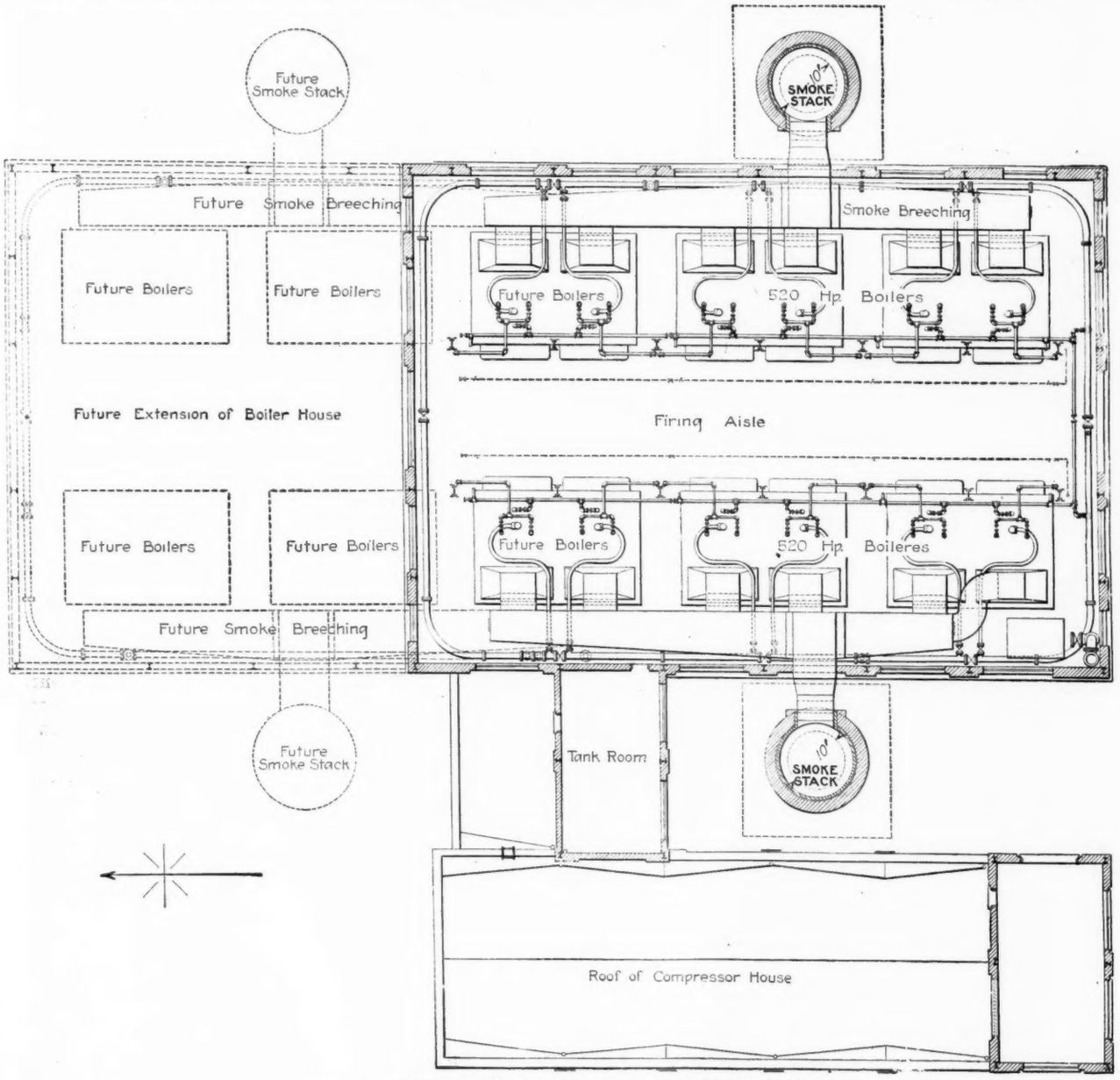

FIG. 2. GENERAL PLAN OF THE NEW BOILER HOUSE

stack, the latter being designed to serve the six boilers that eventually will be located on one side of the present firing aisle, or five boilers to each of four stacks when the extension is constructed.

Reviewing boiler dimensions, it will be found that per hundred square foot of steam-making surface, an allowance has been made of 2 sq.ft. of equivalent grate area and 0.26 sq.ft. of flue cross-section, 0.25 sq.ft. of stack area; and reversing the viewpoint, 7.64 sq.ft. of equivalent grate area per square foot of stack.

Each boiler has an individual damper, and there is also comes from wells near the St. Joseph River. The water is hard and contains a great deal of encrusting solids, particularly calcium carbonate. To eliminate this scale-forming matter, two water-softening units have been provided. These are on either side of the coal-conveyor tower. The water is softened by the cold process, and lime and soda ash are the chemicals used. The water contains on the average about 24 grains of scale-forming matter per U. S. gallon and this in the softeners is reduced to, at the most, 6 grains per gallon. From the softeners the water flows under float con-

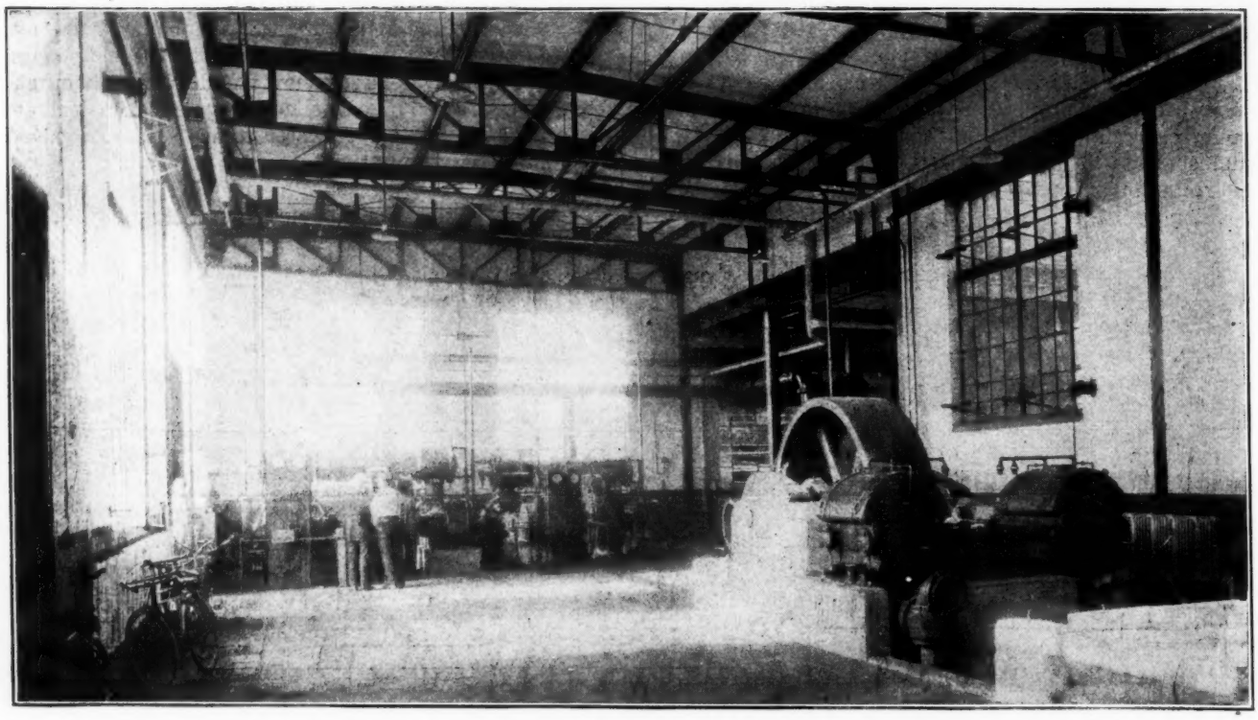

FIG. 3. THE THREE SYNCHRONOUS MOTOR-DRIVEN AIR COMPRESSOR UNITS

trol into a large receiving tank, which also receives the returns from the heating system. During the summer the softeners must work to capacity, as the return water is negligible, but in the colder months they are required to supply only the makeup, amounting to approximately 15 per cent of the boiler-feed water. Water from the receiving tank is elevated to a 6,000-hp. open feed-water heater by either of two turbine-driven centrifugal pumps. Turbine-driven boiler-feed pumps take their suction from the heater

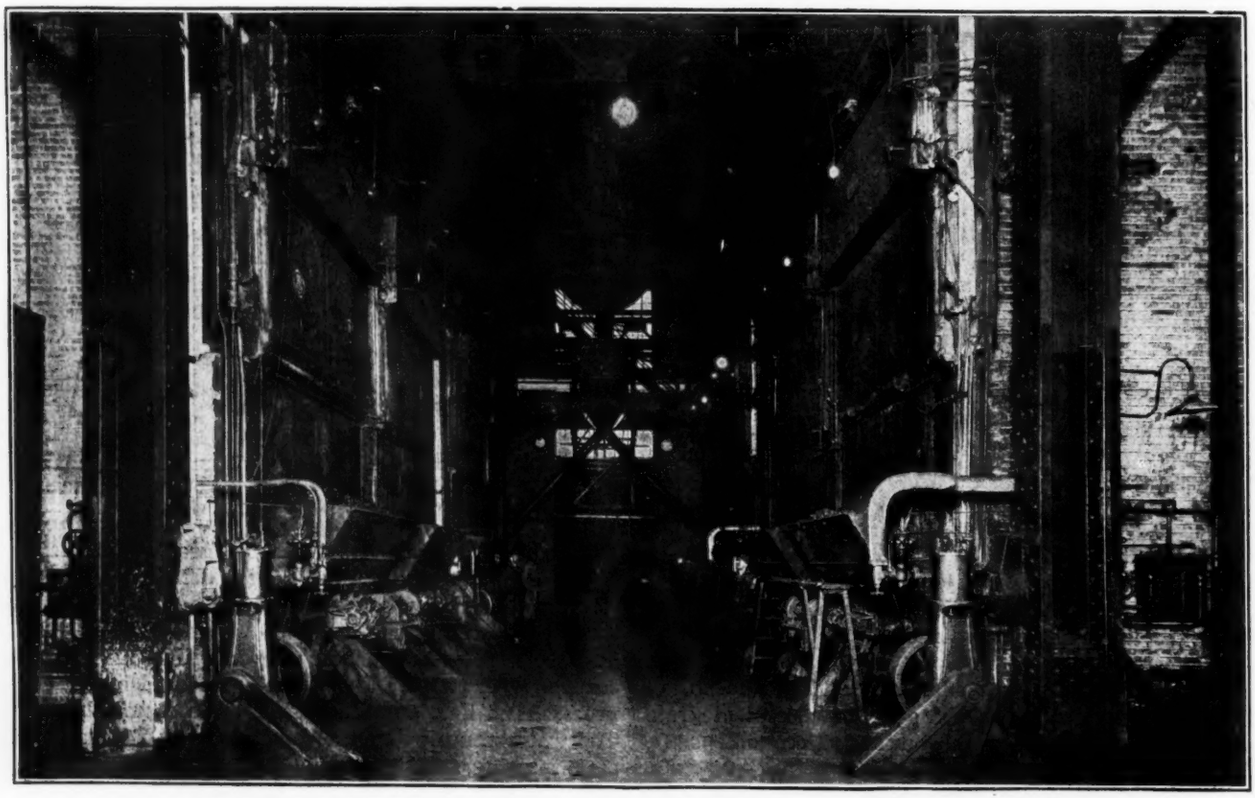

FIG. 4. CENTRAL FIRING AISLE OF THE BOILER ROOM

and force the water to the boilers through a loop feed line. In each leg there is a venturi metering nozzle so that the water may be measured irrespective of the path it takes to the boilers. Provision has been made also to feed the boilers through the blowoff if it becomes desirable due to a mishap to the usual feed-water inlet.

Coal comes to the plant in railway cars and may be unloaded to ground storage by a locomotive crane or directly into a track hopper discharging on an inclined apron conveyor which delivers the coal through a single-roll crusher to a continuous bucket conveyor arranged at right angles to the firing aisle. The coal is trans-

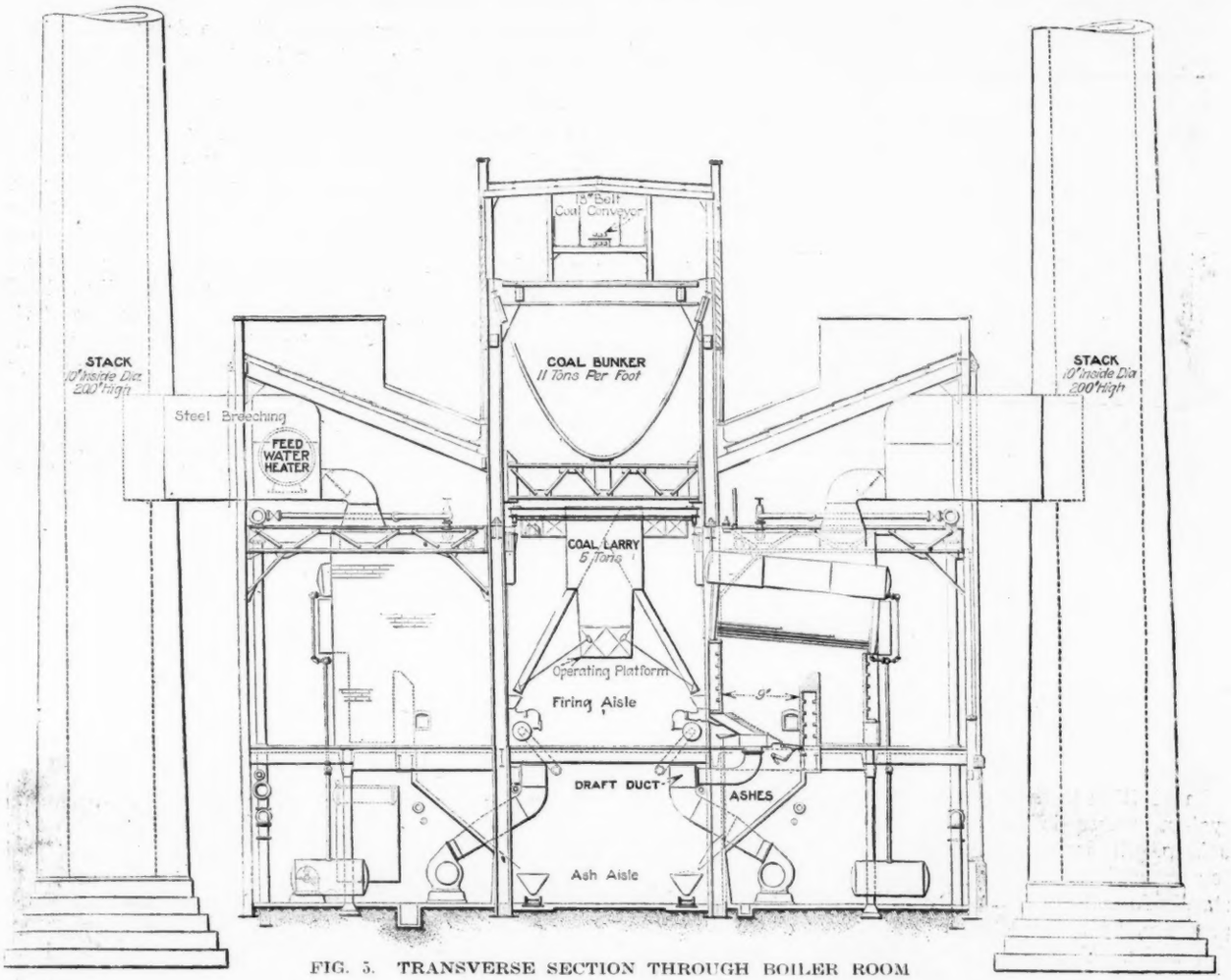

FIG. 5. TRANSVERSE SECTION THROUGH BOILER ROOM

PRINCIPAL EQUIPMENT OF NEW STUDEBAKER BOILER HOUSE

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
8	Boilers	Water-tube	520 hp	Generate steam	175 lb. pressure, 75 deg. superheat	Heine
8	Stokers	Underfeed	Six-retort	Serve boilers	Engine-driven through lineshaft	Taylor
4	Fans	Pressure		Forced draft	Driven by Terry turbines	American Blower Co.
2	Stacks	Radial-brick	10-ft. diam., 200 ft. high	Serve boilers		Custodis
1	Weigh larry	Traveling	5-ton	Weigh coal	Motor-driven	Beaumont
1	Bunker	Parabolic	1,100 tons	Coal reserve for boilers	Steel concrete-lined	Palmer-Bee
1	Crane	Locomotive	16-ton, 15-ft. radius	Handle coal in storage yard		Brownhoist
1	Conveyor	Apron	24-in.	Coal from track hopper to crusher	Motor-driven	Jeffrey
1	Coal crusher	Single-roll	40 tons per hr.	Crush stoker coal	Motor-driven	Jeffrey
1	Conveyor	Continous-bucket	40 tons per hr.	Elevate coal	Motor-driven	Jeffrey
1	Conveyor	Belt	18-in.	Distribute coal to bunker	Motor-driven	Jeffrey & Palmer-Bee
2	Cans	Industrial	18-cu.ft.	Remove ashes		Beaumont
1	Hoist	Skip	2-yd.	Elevate ashes to overhead tank	Motor-driven	Beaumont
3	Pumps	Centrifugal	400-g.p.m.	Boiler-feed	Turbine-driven, 578-ft. head, 3000 r.p.m.	Alberger
2	Pumps	Centrifugal	750-g.p.m.	Feed water from rec. tank to heater	Turbine-driven, 2700 r.p.m.	De Laval
1	Pump	Centrifugal	250-g.p.m.	Domestic hot water	Driven by Lincoln motor, 15 hp., 1750 r.p.m.	Alberger
1	Heater	Open	6,000-hp.	Heat feed water		Cochrane
2	Air compressors	Simple	22x20-in.	Compressed air for shops	40-lb. G.E. syn. motor driven 220-hp., 600 r.p.m.	Ingersoll-Rand
1	Air compressor	Compound	22x14x16 in.	Compressed air for shops	100 lb. Westinghouse syn. motor, 264 hp., 225 r.p.m.	Ingersoll-Rand
1	Air compressor	Compound	25x15¾x18-in.	Compressed air for shops	100 lb. Elect. Mach. Co. Syn. Motor, 234 hp., 200 r.p.m.	Ingersoll-Rand
2	Water softeners	Cold-process	6,000 gal. per hr.	Soften feed water	24 grains per U.S. gal. to 6 gr.	Dodge

Crane Steam Valves, Crane Water Valves, Cadman Everlasting Blowoff Valves, Kelley & Jones Return Valves, Bayer Soot Blowers, Hays Draft Gages, Republic Steam Flow Meters, Builder's Iron Foundry Venturi Meters, Ashcroft Steam Gages, Corliss Steam Traps, Ashton Safety Valves.

ferred to a belt conveyor running the full length of the firing aisle and discharging into an overhead steel bunker having a capacity of about 1,100 tons, or 11 tons per foot of length. The bunker is a parabolic design and is made of steel lined with concrete. From it the coal is delivered to a traveling weigh larry of 5-ton capacity, and it is discharged to the stoker hop-

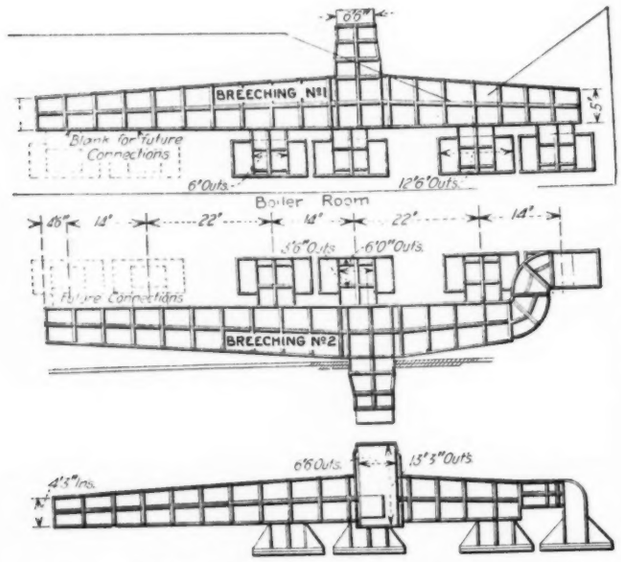

FIG. 6. PLAN AND FRONT ELEVATION OF COVERED STEEL SMOKE BREECHING

pers as required. The larry is motor-driven, as are the coal conveyors previously mentioned, the capacity of the conveying equipment being 40 tons of coal per hour.

In addition to the coal supply the fuel-oil distribution system makes it convenient to burn oil under the boilers. Underground concrete tanks furnish storage for approximately 1,000,000 gal. of oil, which is constantly forced through a circulating system under 40 lb. pressure, by steam pumps located in an aisle between the tanks. The tanks are provided with steam coils which aid in keeping the oil fluid. During a recent coal shortage four oil-burning nozzles using steam as the atomizing force were installed in each boiler and the boilers carried their usual overloads. The nozzles were installed at the boiler front, the sloping stoker face was covered with a checkerwork of firebrick, and a target at right angles to the flame was laid against the bridge wall. The boiler furnace became incandescent and proper combustion of the fuel in the furnace resulted.

Ashes from the stokers are dropped through power dump plates into a pit with a sloping bottom, so that the contents will slide readily into an industrial car, which travels on a track leading outside of the boiler-room basement to a skip hoist. The latter elevates the ashes into a steel tank placed over one of the numerous side tracks for delivery to railway cars. The basement being at ground level makes such a plan feasible.

For its capacity the plant is thus well equipped with labor-saving devices and is of thoroughly modern design. Those responsible for its operation are: G. H. Ahlborn, superintendent of power, and R. G. Kroft, chief operating engineer.

Smith Mechanical Gas Producer

A new type of gas producer in which the fuel is distributed mechanically over the bed and the poking done automatically in preference to hand manipulation, has been developed by the Smith Gas Engineering Co., of Dayton, Ohio. From coal of widely varying composition and firing characteristics, it is designed to produce clear cold gas of constant quality so desirable for gas-engine use or for distribution through a system of piping for industrial heating purposes. The basic essentials that have been observed in the new design are a deep fuel bed 4 ft. to 5 ft. thick, uniform distribution of air to the fuel bed, constant proportions of air and steam in the blast under all conditions of load, moderate rate of gasification to avoid clinker, viscous tar or lampblack, and ease of inspection and manipulation without the escape of obnoxious gases.

In a producer the combustion zone ordinarily extends about 18 in. into the fuel bed. The temperature of the gas leaving this zone is obviously that of the zone itself, but if the fuel bed is 5 ft. deep, as is the usual practice in the producer under discussion, the hot gases must pass through 3½ ft. of descending fuel and give up a considerable portion of their heat to the coal. At the top of the producer the gas is cooler, and when fresh coal is distributed over the top of the bed, it

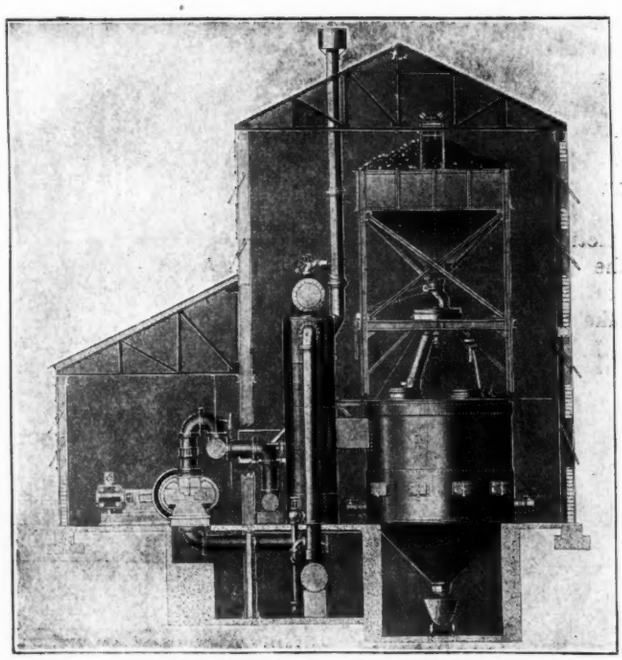

FIG. 1. NEW DESIGN OF SMITH GAS-PRODUCER PLANT DESIGNATED AS TYPE G

is not exposed immediately to the higher temperature of the fire. The coal is thus distilled slowly, avoiding the production of viscous tar and lampblack; besides, the heated coal above the combustion zone provides a reservoir of heat that may be quickly gasified to take care of overloads and insure an uninterrupted flow of gas.

Reference to Fig. 2 will show that the fuel bed is supported on cast-iron grates which are manipulated by steam pressure when it is desired to clean the fire. The entire cross-section of the bed is exposed to the action of the air and water vapor mixture and the bed

is of uniform thickness, so that no greater resistance to draft passage is offered at one point than at any other.

To secure at all loads a constant proportion of water vapor in the air drawn into the generator, the draft is held constant and the air, by thermostatic regulation, is maintained at the temperature at which it will take up the desired amount of water vapor.

One of the essentials of a successful producer is a moderate rate of gasification. This is accomplished by providing ample grate area. It is impossible to secure continuous operation where hard driving is necessary, because rapid firing means high temperatures, which in turn result in clinker troubles and shutdowns.

Operating the producer under suction permits inspection and manipulation without exposing the operators to the dangers of poisonous gases. The gates and ashpit can be inspected by opening the doors provided for the purpose, and the top of the fuel bed can be seen by opening peek-holes in the generator top without permitting the escape of gases. If the ashpit doors are open for any length of time while the producer is under load, the pressure of the incoming air can be balanced by the use of a steam jet or power-operated blower attached to the saturator inlet. This insures saturation of the air, and the same gas-making conditions are maintained during the grate-cleaning period as in normal operation.

Earlier types of Smith gas producers were square or rectangular in cross-section, and increased capacity was obtained by the addition of similar units. Reference to Fig. 1 will show that the new type is circular, the change being brought about to make possible the mechanical charging and poking of the fuel. The producer top is supported by structural-steel framing and is suspended from a roller bearing to minimize the friction from rotation. A water seal is provided around the top of the producer shell, and sway rollers are spaced around the periphery of the rotating element to take care of unbalanced loading.

In the top two rotating turrets eccentrically located with respect to the generator axis have been provided. Within one of these turrets is mounted a steam-operated poker, while the other turret contains a fuel-distributing device including arrangements for feeding the coal in varying quantities and for dropping it uniformly over the fuel bed. The poker cylinder is also placed eccentrically on the turret and at an angle slightly off the prependicular. When the poker is extended and in the "out" position it will reach the generator lining, and in the "in" position, the center of the fire.

A small steam engine mounted on the generator serves to rotate the top, the charging turret and the poker turret, the motion being effected intermittently by means of ratches devices. During the "out" stroke of the turning engine, pawls for moving the top and the poker turret engage, causing these two rotating parts to advance. On the "in" stroke of the engine these parts are at rest and the charging turret advances. While the poker turret and the top are at rest, steam is admitted automatically to the poker cylinder and the poker itself is forced down into the fuel bed and withdrawn in much the same manner as a man would poke the fire by hand. The cycle is repeated in regular and continuous order. The speed of the poking operation, however, is under the control of the operator, as he can vary the speed of the engine which rotates the top and can engage or disengage the poker and charging turret at will.

The cleaning and cooling apparatus supplied with the new producer are of standard design. Upon leaving the generator the gas is conducted through a brick-lined downcomer to a primary cooler of the static type, where its temperature is reduced to that most suitable for the efficient operation of the tar extractors. The gas then passes to a low-pressure main, from which it is discharged to the inlet of the gas pump. The latter is of the positive type, designed to operate under a

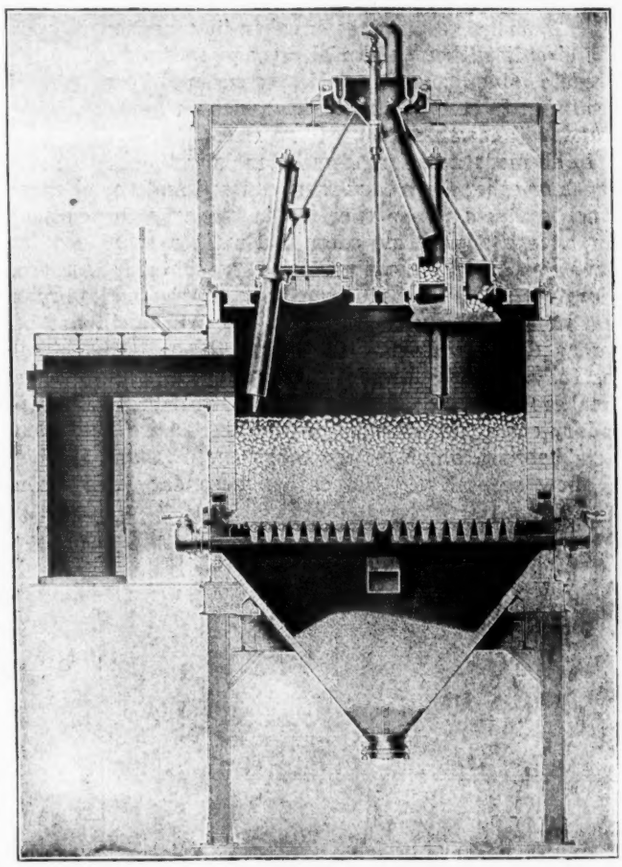

FIG. 2. CROSS-SECTION OF TYPE G GENERATOR, SHOWING THE AUTOMATIC STOKING AND POKING EQUIPMENT

maximum pressure of 5 lb. per square inch. The gas is then delivered by the pump under sufficient pressure to overcome the resistance of the tar extractors and the friction in the line. Power for operating the pump is furnished by a direct-connected steam engine controlled by a governor automatically adjusted to vary the speed of the pump to meet the demand for gas, so that no holder or gas storage is required.

The tar extractors are of the familiar spun-glass type, and a suitable number are provided with each producer to permit replacing diaphragms without interfering with operation. The tar is dropped from the gas main immediately beyond the extractors. The gas passes on through a secondary cooler of the static type, which is designed to reduce the gas temperature to that of the atmosphere.

At present the new producer is made in three sizes, the generators being 9, 14 and 16 ft. in diameter with capacities to gasify 800, 1,600 and 3,000 lb. of coal per hour, respectively.

Maintenance of Carbon Circuit Breakers

Action of Circuit Breaker When Opening—Care of Contacts an Important Feature in Satisfactory Operation—Causes of Heating and How To Prevent It—Care of Attachments and Other Features in Circuit-Breaker Maintenance

By W. M. AUSTIN
Supply Engineer, Westinghouse Electric and Manufacturing Company

THE maintenance of carbon-break circuit breakers can broadly be divided into two main divisions; namely, keeping the breaker in condition to open the circuit without material damage to itself under the predetermined conditions of opening, and keeping it in condition to carry its rated load without more than the standard allowable temperature rise.

In all modern carbon circuit breakers there is a main brush or other form of moving contact, and one or more other contacts whose function is to carry the current for a very short time after the main moving contact separates from the main stationary contact. An arc, therefore, will not be drawn between the main brush and the stationary contact, and the brush will not be damaged and will be able to carry the rated load successfully when the circuit breaker is again closed. Some breakers have, in addition to the main contacts, secondary contacts, tertiary contacts and final carbon contacts, between which the arc is broken. *T*, *S* and *M*, Fig. 1, show respectively the carbon secondary and main

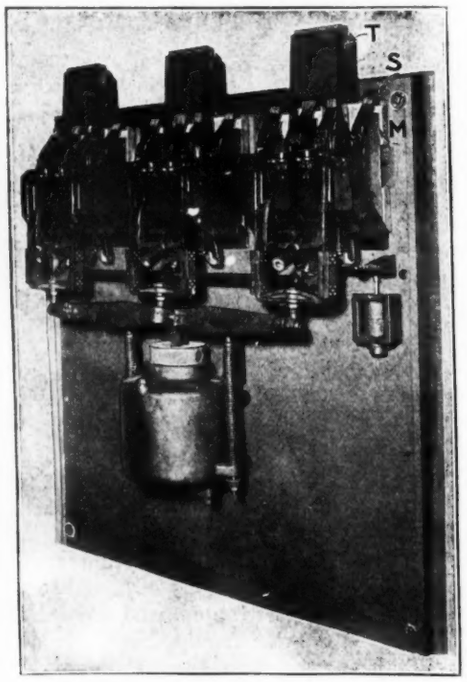

FIG. 1. ELECTRICALLY OPERATED THREE-POLE, 12,000-AMPERE CARBON CIRCUIT BREAKER

contacts. The diagram, Fig. 3, shows the shape and relative position of each of the contacts for a breaker of large ampere capacity in the three important stages of breaking the circuit as follows:

1. Contacts outlined by dotted lines show main brush opened, secondary contact on point of opening, and tertiary and carbon contacts not changed from closed position.

2. Contacts indicated by double shading show main and secondary contacts open, tertiary and carbon contacts still closed, but one set of contacts has slid down on the other set.

3. Contacts shown by single shading indicate the tertiary contact open and carbon tips about to finally break the circuit.

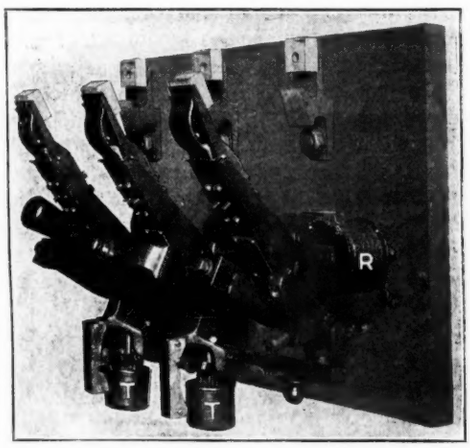

FIG. 2. THREE-POLE BREAKER WITH INVERSE-TIME ELEMENT AND UNDERVOLTAGE RELEASE

These contacts, as they open successively, increase the resistance in the circuit and to a certain extent limit the value of the current at the time the carbon contacts open. However, if the resistance in the contacts is too large when the brush opens, the brush will draw an arc and the resulting scars will lessen the ability of the brush to carry full load thereafter.

When breaking any considerable current, there is always an arc between the carbons, and when the carbons are so roughened and burned that the contact resistance is very high, there will be an arc between the tertiary contacts. When the arcing on the tertiary contacts has taken place enough times, the contact resistance has become high enough to cause arcing on the secondary contacts when they open. If secondary contacts become sufficiently roughened by the arc, the brush and main stationary contacts will begin to arc when the breaker opens. It is therefore necessary, in order to keep the breaker in condition to carry its rated load without getting too hot, to keep the parts of the breaker that are used to open the circuit in good condition also.

Whenever the secondary or the tertiary contacts become rough, the breaker should be opened at the first opportunity and the contacts filed until they make a good contact. If the carbons are burned so that the contact area is materially lessened, they should be dressed to make as good contact as is possible. If they are broken or very badly burned so that they cannot be put in good condition, new carbons should be installed.

Likewise new secondary and new tertiary contacts should be put on when they are worn or burned out.

Properly designed and installed breakers will carry their rated amperes without overheating as long as the contact resistance between the main moving (brush) and stationary contacts remains normal, unless some other electrical connection is defective. One cause of overheating of circuit breakers is the use of insufficient lead capacity or the use of a hot ammeter shunt too near the breaker. Another cause of overheating is defective contact between parts of the conducting material other than the main (brush) contact; for example, nuts clamping terminals or busbars to the studs may have poor contact with the studs or with the terminals or busbars. This poor contact may be due to insufficient contact pressure, insufficient contact area, or oxidized or corroded contact surfaces. If the contact pressure is not enough, it is obvious that tightening the nuts is the remedy. Insufficient contact area may be due to untrue surfaces on the nuts, studs or busbars or terminals, or too small or too few nuts. Contact surfaces that were true when made may become untrue by being battered, raising high spots on the surfaces. When the amount of battering is small and the surface is plain, the best way is to carefully file off the high spots; if the injury is serious, it is best to machine the surface. Where the threads on the studs are battered, they can usually be partly restored by filing away the high spots with a small three-cornered file.

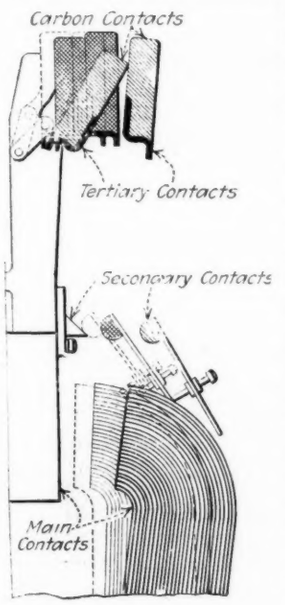

FIG. 3.
CONTACTS FOR CIRCUIT BREAKER FIG. 1

Oxidized and corroded surfaces of threads on studs and nuts may be cleaned by rubbing with a brush, a piece of cloth, or waste dipped in a mixture of water and powdered pumice stone, or some other finely ground scouring material.

Overheating may be due to a defective soldered joint. It often happens that a soldered joint that was good when made has been partly broken by too great a mechanical load on the joint, the heat then developed has melted the solder, causing it to run out. A soldered joint may be spoiled similarly by an overload, causing the solder to melt and part of it to run, rendering the joint incapable of carrying its rated load thereafter.

The most frequent cause of overheating of carbon circuit breakers is bad contact between the main moving and stationary contacts. Poor contact on the main (brush) contacts may be due to any or all of the three causes; that is, insufficient pressure, insufficient area in contact and oxidized, corroded or dirty surfaces. Any carbon circuit breaker, if allowed to stand without attention, will heat up when loaded, owing to oxidation. It should be opened occasionally and its contact surfaces cleaned; if this cannot be done, it should be applied very conservatively. If the brush has insufficient contact pressure, adjustments should be made to secure the required pressure. If the whole or nearly the whole contact area of the brush does not touch the opposing contact, it will be necessary to refit the brush with a file or otherwise, so that it makes contact as intended.

A good way to determine whether the brush and opposed contacts are touching each other is to mark the brush with a soft pencil and then close the breaker with a piece of thin paper between the main contacts. If the whole area is making contact, every lamination of the brush will make an impression on the paper. If there are spots where the brush does not touch the stationary contact, blank spaces will show on the paper.

If the contact surfaces are oxidized or corroded, they should be cleaned with fine sandpaper. A good way to hold the sandpaper is to tack it to pieces of hardwood as shown in the upper sketch of Fig. 4. Dirty contact surfaces can be cleaned readily by the use of alcohol, gasoline, ammonia, water and soap, or other solvents.

It is important to note that breakers with semi-eliptic brushes usually give more trouble with the contact between the brush and bottom stud than they do between the brush and top stud. This is due to the fact that in most cases the bottom end of the brush and the contact surfaces of the bottom stud are not as accessible as the top stud and the top end of the brush, resulting in more or less neglect of the bottom contact. The lower sandpaper holder, Fig. 4, is made especially for use on the lower stud and lower end of the brush, where it can be reached only from above.

Transferring Circuit Breakers

A prolific source of trouble with carbon circuit breakers is the transfer of the breaker from the base on which it was mounted in the factory to a panel of a switchboard. Most carbon circuit breakers depend on the base to hold some of the parts in proper relation to each other. The bolt holes in the panel are usually one-sixteenth to one-eighth inch larger than the bolts so as to enable the various parts to be shifted slightly to bring them in line with each other. Any good mechanic ought to have no difficulty in transferring a breaker from one panel to another, but if he has never done a similar job before, he will have to exercise much care until he has become familiar with the apparatus so that the moving parts will be free and the brush and other contacts properly adjusted.

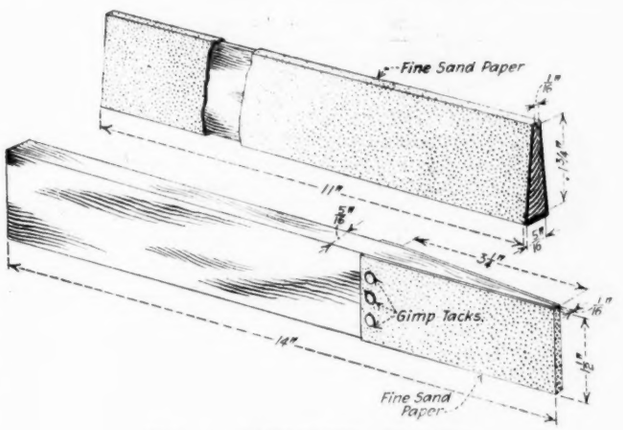

FIG. 4. SANDPAPER HOLDER

Circuit breakers are usually provided with an overload trip, and often with a shunt trip, an undervoltage trip, an underload trip, a reverse-current trip, or an

inverse-time-limit overload trip. Some circuit breakers are also provided with a closing coil.

Undervoltage trip coils and the shunt coils for the reverse-current trip are subjected to their rated voltage continuously. When this voltage is large, the coils are sometimes protected by an external resistance. The use of an external resistance permits winding the coil with larger wire, making it stronger and more durable.

Undervoltage coils and reverse-current shunt coils (with their resistances when used) are designed to withstand a definite line voltage. If they are subjected to a voltage much in excess of the rated voltage, they

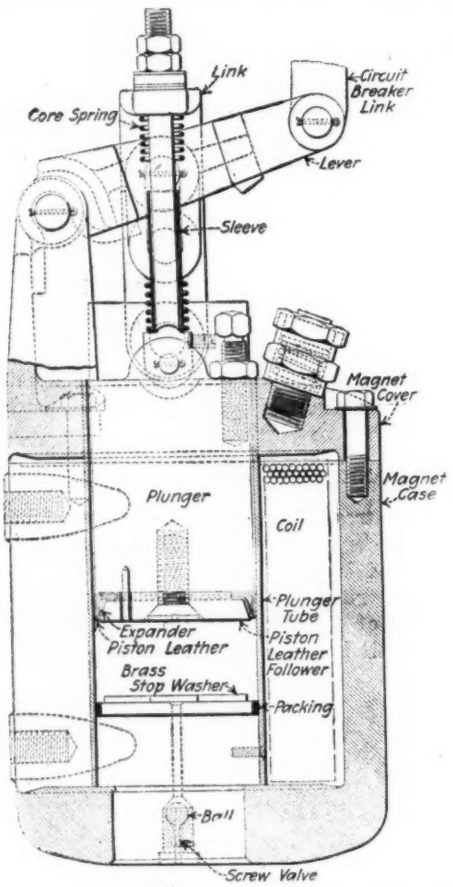

FIG. 5. CLOSING MAGNET WITH AIR DASHPOT

will finally attain a temperature which will destroy the insulation of the coil.

Alternating-current undervoltage coils usually are connected so that voltage is removed from the coil when the circuit breaker opens. Where alternating-current undervoltage coils remain in circuit after the breaker opens, a means of retrieving the armature to its closed position by the opening of the breaker is provided, as explained in the article, "Circuit-Breakers—Principle of Operation," by Victor H. Todd in the Oct. 5 issue. This prevents undue current flowing through the coil owing to open magnetic circuit and consequent overheating. Careful inspection should be made to see that complete retrieving is obtained.

Shunt-trip coils and closing coils are subjected to the voltage of the control circuit only during the time of opening and closing of the breaker. If the breaker is closed and tripped a good many times in a short period, excessive heating of the coils may result. Voltage must not be kept on such coils continuously.

Closing coils are usually designed to close the circuit breaker between certain maximum and minimum voltages. These limits are usually as wide apart as it is reliable and safe to operate. If the voltage is lower than the minimum, the circuit breaker is liable not to close; and if it is above the maximum, it is liable to cause damage to the breaker on account of the excessive speed of closing. Especially, it is liable to break the carbons.

When figuring the actual control voltage that will exist at a breaker, account must be taken of the drop in the control wires. The range of voltage marked on the nameplate means the voltage at the coil terminals, therefore the control-bus voltage must be selected with this in view.

In order to stop the breaker at the end of the opening stroke, a friction spring device and buffer are sometimes provided. To be effective, the friction buffer should be so adjusted as to give sufficient pressure between the surfaces to retard the break so that it will not bound back or hit too hard at the end of the opening movement. On electrically operated breakers care must be taken not to have too much friction or the breaker will fail to close on the minimum operating voltage.

Dashpots Used on Some Breakers

On some heavy electrically operated breakers, dashpots are used to lessen the shock due to closing on the higher part of the control range (See Figs. 1 and 5). Such dashpots usually have adjustable valves. The valve should be set to give best operation at the control voltage used on each particular breaker. Regular inspection should be made and the piston leather kept oiled and clean and the valve passages free from dirt. Before being put in operation, this whole piston and valve mechanism requires inspecting to see that no dirt or refuse from packing has accumulated and that all parts are free from rust, etc.

"Inverse-time-limit" tripping is usually accomplished by attaching some kind of dashpot to the moving element of the tripping magnet such as at *T*, Fig. 2. Two kinds of dashpots have been used for this purpose. In the piston dashpot, Fig. 6, a piston is arranged so as to move slowly for some distance against the resistance of the working fluid, then the fluid ceases to offer resistance and the remainder of the movement is very rapid, tripping the breaker at or near the end of the movement. The action of such a dashpot usually is varied by the adjustment of a pin valve. The sucker disc dashpot, Fig. 7, consists of two surfaces in intimate contact, the contact surfaces being immersed in oil or other viscous fluid. One of these surfaces is movable and is attached to the moving element of the trip magnet. Unless the pull of the trip magnet is as great as or greater than the product of the atmospheric pressure in pounds per square inch, and the area of contact in square inches between the contact surfaces, the moving member will be held without appreciable movement until the oil or other fluid can flow between the surfaces, the time required to separate the surfaces varying approximately inversely as the pull and directly as the viscosity of the oil. If the time limit is too short, it can be lengthened by using a more viscous oil.

To keep the inverse-time limit in good working order, it is necessary that the oil be kept clean. A single particle of dirt between the two surfaces of the sucker dashpot will sometimes reduce the time nearly to zero.

The engaging surfaces must be protected so that no high spots appear on either surface. If imperfections appear in the surface due to bruising or other cause, all high spots should be removed with a scraper. Experience has shown that satisfactory operation can be had with the oil one-quarter inch deep above the stationary surface.

With defective adjustments it may happen that when the moving element of the overload, reverse-current, or shunt-trip magnets moves to trip the breaker, the breaker fails to open. One reason for this happening is that the moving element strikes the latch too early in its movement; that is, before it has accumulated enough energy to open the latch. In cases like this, adjustments should be made so that the latch is freed just before the moving element of the magnet strikes the stationary element.

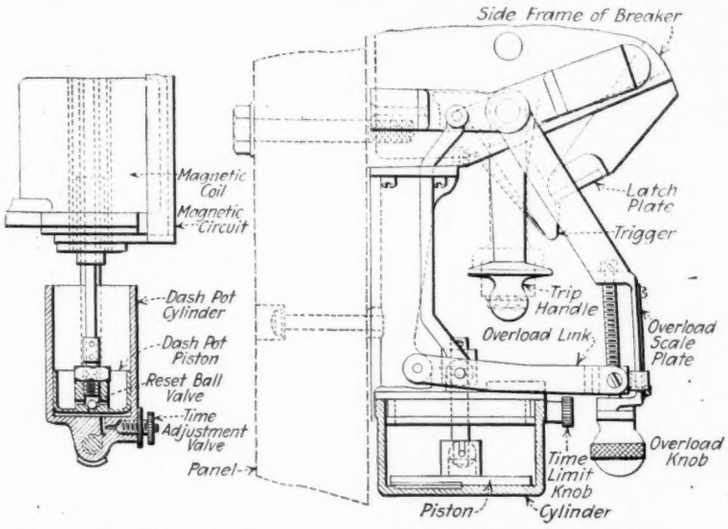

FIG. 6. PISTON DASHPOT

FIG. 7. SUCKER DASHPOT

Any circuit breaker has a little oil put on each pin or shaft when it is being assembled. In time this oil works out. Before the bearing becomes dry, one or more drops of oil should be applied and worked into the bearings. All excess oil should be thoroughly wiped off so as to prevent the accumulation of dust or dirt. If this oiling is done regularly, there will be no danger of the breaker failing to open when it is unlatched by the trip magnet or by hand.

Determination of the Radiation Correction of a Throttling Calorimeter

BY RALPH I. ALEXANDER

Whenever a throttling calorimeter is used to determine the quality of steam, the fact must not be forgotten that a certain amount of the heat content of the steam is dissipated to the surrounding air. This radiation often introduces a considerable error in the final determination of the quality, no matter how well the calorimeter may be protected by insulating felt or asbestos.

In order to make proper allowance for this error, the following method, after the late Professor Spangler, and used with various modifications since, has been found successful as applied to boiler tests. The sample pipe of the calorimeter should be placed between the boiler and the stop valve, never after the stop valve. At the conclusion of the boiler test the fires should be banked, firedoors left open and the top valve closed tight.

The result of these adjustments is to stop the boiler from steaming, but owing to stored heat in the setting and water, the pressure will be very slow to drop. During the first hour following the stopping of the test, the drop in pressure will be practically nil. Whatever steam is formed will be dry and saturated. It should be noted that while the stop valve has been closed the position of the calorimeter allows it to continue in operation, and it should be allowed to function for an hour after the completion of the boiler test. At the end of this time readings should be taken upon both thermometers of the calorimeter and also from the manometer, which is always used to give readings of steam pressure on the discharge side of the calorimeter.

No boiler test should be conducted without obtaining as a part of the data, readings from the barometer. This barometer reading added to the manometer reading as just determined. will give the absolute pressure in inches of mercury at the calorimeter discharge. If more convenient for use in the steam tables, this reading of inches of mercury may be transposed to read in pounds per square inch by multiplying by 0.491. With this reading and the temperature of the steam discharging from the instrument, the steam tables may be consulted to determine the total heat content of the steam at this point in the calorimeter. It will of course be necessary to find this reading of heat content in a table for superheated steam.

The reading of the steam pressure in the boiler is found by noting the pressure on the steam gage. The pressure gage should be calibrated, in order that the true reading may be known. Because under the conditions of the test the steam in the boiler is dry, again consulting the steam tables (saturated steam tables), the total heat for the given gage pressure will be found.

The basic principle on which the throttling calorimeter depends for its success is that there is no heat loss due to the passage of steam through the orifice plate. Therefore the two total heat values, as previously determined, should be equal. It will be found by comparison that such is not the case, and the difference in the two results is the radiation loss of the calorimeter. It will amount to several B.t.u., depending upon how well the calorimeter is insulated. This correction should now be added to the total heat content of the steam discharging from the instrument as previously determined during the boiler test. The solution for the quality of the steam may then be determined from the formula

$$x = \frac{(i + R - q)}{r}$$

in which

x = Quality of steam (unknown);
i = Total heat of the superheated steam on the discharge side of the calorimeter in B.t.u.;
R = Radiation correction, or loss of the calorimeter expressed in B.t.u.;
q = Heat of the liquid of the boiler steam expressed in B.t.u.;
r = Heat of vaporization of the boiler steam expressed in B.t.u.

It may be added that the reason for using two thermometers, one on each side of the throttle plate, is to determine the proper correction of the temperature reading of the thermometer on the discharge side of the calorimeter. The error in this case is due to stem exposure. Both thermometers should preferably be of the same pattern, of the same length, and with the same scale. They should be placed in thermometer wells of equal depth. While the calorimeter is in operation, it will be noticed that the reading of the thermometer on the high-pressure side will record lower values than the temperature of saturated steam corresponding to the boiler pressure as indicated in the steam tables. Notice on both thermometers the height that the mercury stands above the top of the thermometer wells. If the thermometers are identical in type these measurements may be made as the number of degrees of exposed mercury as indicated by the scales of the thermometers. The error, as just determined, of the thermometer reading on the high-pressure side is multiplied by the ratio of the two measurements of stem exposure. The result will give the thermometer correction to be applied to the temperature reading from the discharge side of the instrument. The following example illustrates:

Temperature reading from high-pressure side of instrument, deg. F.	336.5
Steam pressure, absolute, lb.	116
Temperature of steam corresponding to pressure, deg. F.	338.7
Difference of temperature readings, deg. F.	2.2
Temperature reading on low-pressure side of instrument, deg. F.	348.3
*Stem exposure on high-pressure side of orifice plate (336.5-80) deg. F.	256.5
*Stem exposure on low-pressure side of orifice plate (348.5-80) deg. F.	268.3
Error to be applied to thermometer reading on low-pressure side of orifice plate $\left(\frac{268.3}{256.5}\right)$ (2.2) = deg. F.	2.30
Correct reading of each thermometer, deg. F.:	
High	338.7
Low	350.6

*The thermometers in this case were immersed in thermometer wells to the 80 deg. reading.

In any series of calorimeter readings it is always good practice to interchange thermometers after each reading, the object being to equalize the error when the readings are averaged at the end of the test.

Some Points About Dense-Air Refrigerating Machines

By W. D. Forbes

The use of what are known as chemical ice machines, such as ammonia and CO_2, is without any doubt the most economical means of obtaining ice or of chilling rooms artificially. The use of free air is well known to the students of refrigeration, but it is not well understood by many of them.

While the system of air as a refrigerating medium is more expensive, there are conditions where air is preferable to chemicals. The conditions may be broadly stated as where power is cheap, where water power is obtainable, where the plant is far from places where chemicals are produced, where the shutdown of an ice plant because of a lack of chemicals would be serious.

The theory of free air refrigeration is simple. It requires a compressor cylinder, an expander cylinder and power to work both. In the United States Navy the dense-air ice machine has been used for years. To explain how a machine of this character works, I will describe one of the most widely used of this class.

Standing at the cylinder end of the machine, a compressor cylinder is found mounted on a substantial bed at the right; on the left is the expander cylinder, while between them is a steam cylinder which furnishes the power.

At the far end of the bed is a single-throw crankshaft mounted in bearings supported in jaws cast with the bed. The crank is connected with the steam cylinder, and on the two overhung ends of the crankshaft are mounted two heavy flywheels, in which are the crankpins for the connecting rods of the compressor and expander cylinders. These flywheels have their connecting rods coupled in the usual way to the crossheads, only the compressor cylinder crosshead has its pin extended out right and left and to these two extensions are connected a water-circulating pump on the left and an air primer pump on the right. Above the bed, and supported on the two outside cylinders and brackets cast on the back of the main bearing supports, is a cooler in which is a copper cooling coil. Of course the ends of the cooler, which is a cylinder, are closed with heads. Two eccentrics are fitted on the crankshaft and they work two rocker shafts supported on the bed, and the rocker shafts in turn work the two main and the two cutoff valves of the compressor and expander cylinders as well as the single slide valve of the steam engine.

The Cycle of Operation

The cycle of the machine is as follows: The steam engine turns the crankshaft, and its two flywheels actuate both compressor and expander cylinders. The compressed air, which has become heated by being compressed, passes from the valve chest through copper connections, to the copper cooler coil; water supplied by the water pump surrounds the coil. The hot compressed air, cooled somewhat, is then led through a moisture separator in the front end of the cooler head, on through a copper pipe back to the valve chest of the expander, and here, as it is of considerable pressure, it aids the steam engine in turning the machine.

The expanding of the compressed air, coupled with the work it has to do on the piston of the expander, results, of course, in a low temperature. The cold air is then led by pipes to an oil separator, which extracts most of the lubricating oil used in the cylinders. The cold air then passes on to an ice-making tank, which, however, is connected to the main line leading to the chillroom, so that it can be cut out when no ice is wanted. From the chillroom coils the cold air is returned to the valve chest of the compressor cylinder, thus completing the cycle, which is a closed one.

The primer pump resupplies any air that seeps out of the system. If the system could be kept absolutely tight, the primer pump would not be needed except in starting the machine. The primer-pump plunger is hollow, and at its front end several small inlet holes meet the bore; at the back end a foot valve is screwed into the plunger. This pump partakes of the same motion as that of the compressor piston and rod and pumps air into the system through a check valve whenever leakage occurs, thus automatically working only when needed. The primer-pump body is built into the compressor-cylinder casting, which is water-jacketed, the bore being made with a removable liner, and the same water pump furnishing the cooling water for the cooler keeps the jacket water moving; thus the primer-pump body is also cooled as well as the cylinder.

The piston of the compressor is provided with two cup-shaped leather packings, held in their places by two followers, the cupped packings looking away from each other. These packings are also used in the same way in the expander. Aboard ship it has been found more satisfactory to drop off the direct-connected water pump and connect the water-cooling system with the bilge or some other pump, for in southern regions the water being warm, a greater volume is required than can be obtained through the connected pump.

When the system is in working order, the gage of the compressor should show 270 lb., while the gage of the expander should show 60 lb., and this relation should be closely maintained if good work is expected.

In manufacturing the machines, the valves are set first by empirically determined positions, then indicators are used to set them finally. I suggest to anyone in charge of this air type of machine not to try to reset the valves without using indicators. The valves in the Allen machine are of the slide type. I made some experimental runs with valves of this type and then changed them for single-acting valves in the compressor, and found that the economy of the latter, as regards refrigeration, was just a little better than with the former, but the self-acting valves showed an economy of power.

Small Air Leak Will Impair Efficiency

In running a dense-air machine, those in charge must closely care for the tightness of the system. A small air leak will run the efficiency of the system down, or if there is any bypassing of the air in the compressor or expander, the system will at once give trouble.

The oil used in the compressor should be one suited to withstand the heat of compression, while that used in the expander must withstand the cold, which can be and is often brought below zero F. I have seen a plant put out of action by having these two grades interchanged. Of course the bearings of the machines require oil of the usual character for such work. Both expander and compressor cylinders are oiled by special sight-feed oilers or cups, as are the piston rods and valve stems of both the cylinders. The oil for the piston rods feeds into an oil ring set about the middle of the metallic packing. Metallic packing is also used on the valve stems, which are furnished with oil rings.

When it comes to taking charge of an air ice plant, the things to look out for are at first perplexing, as a drop in pressure may occur from many causes. The first thing to do is to see if the primer-pump foot valve is working, also its check valve. The first may be listened for and the second also. If the check valve is not working, a few smart blows on its body will often start it; if the foot valve of the primer pump is not acting, it must be taken out, cleaned and perhaps ground. To do this the cap must be taken off the pump body, the forward nuts of the plunger cast adrift from the extension of the crosshead pin, and the plunger backed out. Care should be taken not to disturb the position of the two nuts on the reduced part of the plunger, as in returning it its end may strike the cap and wreck it or the foot valve. Grind the foot valve or check valve with ground glass; do not use emery.

To detect leaks, all joints, piston rods and valve stems must be soap-watered, the joints of the valve chests and cylinder covers not being overlooked. The pipe joints throughout must be gone over, not only at the machine, but at the ice tank, grease trap and chillroom.

The gaskets of the valve chest and cylinder heads are all metallic and are made up with litharge. To remove the pistons, a socket wrench is required and care must be taken not to shift the pistons' positions, as a head may be knocked out if they are not exactly replaced. It will be noticed in this machine that there is an adjustment provided for the pistons, and by slacking back on the capscrews in the crossheads the piston rods can be turned in the crossheads, and a wrench is provided to fit the squares milled on the piston rods for the purpose. The followers and bull rings are provided with small tapped holes into which rods are screwed to remove these parts easily.

To replace the leather packings of the pistons is an easy job, but care should be taken to have the hands clean, as a little grit on the leathers will scratch the polished surface of the bores and injure them. The leathers come cut to size and in neatsfoot oil, and all that has to be done is to form them up a little with the fingers and shave the edges nicely. After the pistons are made, the valve chests should be opened and the valve faces examined. The compressor valves give much trouble by cutting, and if the lubrication is not thorough, the faces of both valves and seats will cut in a few minutes. False seats are sometimes fitted in the valve chests and the surfaces of the main valve seat are awkward to reach and scrape, but the machine will not give proper refrigeration unless the valve seats are all in first-class condition. The main valves of the cylinders have crooked ports, and their passages are tested to see that the walls are solid, as sometimes these walls leak. If the machine does not keep up pressures or equalizes when all joints, valve seats and stuffing boxes are tight, the leaking or seeping of the dividing walls in cylinder or valves may be the cause of the trouble. To test out the main valves and cylinders, the passages must be blocked and water pressure applied.

Proper Resetting of the Valves

To cast adrift the cutoff and main valves is a real job, and to return them to their original position, trams should be made. These trams are not furnished with the machines, but unless the valves are reset just as they were, it will take some time to run tests to properly reset them.

If the passages show spongy in their walls and therefore bypass the air, they can be rusted with salammoniac, and this will answer for a time.

The best way, however, is to use melted sulphur and to do this in the cylinders they have to be removed from the bed to tilt them so the sulphur will run where it is wanted. Before trying to run the sulphur, the metal must be heated as much as possible or the material will not enter the pores of the metal and only a surface joint will result; but if the metal is sound and hot, the joint will be permanent.

The copper cooling coil in the cooler becomes corroded after a while, but when this occurs the pressures run down so quickly that an observer will almost at once surmise the cause. When the trouble is located, there is nothing to do but replace the coil with a new one or patch up the old one temporarily by soldering.

In the design of this machine the placing of the cylinder of the steam engine between the two other cylinders is, in my opinion, a mistake from the economy

standpoint, but it makes a compact machine. It is clear that a hot steam cylinder should not be put close to the cold expander cylinder, though it is heavily lagged; nor should heat be transmitted to a compressor cylinder. Again, the use of a system of slide valves in the compressor is ill-advised, and self-acting valves as tested by me clearly show that the great trouble with the cutting of the compressor slide valves would be done away with.

Steam-Heated Fuel-Oil Pipe Line in Underground Conduit

When P. Ballantine & Sons, of Newark, N. J., decided to construct a new boiler plant, the question of fuel came to the fore. This was during the period when soft coal was hard to obtain and of poor quality at that, and it was decided not only to equip the new boilers with mechanical stokers, but to provide for burning fuel oil as well. The new boiler house contains four 500-hp. water-tube boilers and space has been provided for the future installation of two more, making a total of 3,000 horsepower.

In installing the proposed fuel-oil system, a 3,000,000-gal. storage tank was built close by a railroad siding and buried in the ground. The tank is made with four compartments, each 22 ft. 6 in. by 30 ft., and 15 ft. deep to the overflow; each compartment holds 77,269 gal. At one side of the tank is a pumphouse containing two duplex oil pumps, Fig. 2, so piped that one can pump from a tank car, Fig. 1, to the reservoir while the other is pumping from the reservoir to a small storage tank at the boiler house, or both can be used to pump from the tank cars, there being room for three cars to be placed for unloading at once.

In the new boiler house there are two similar pumps which pump from the small storage tank buried in the ground, just outside of the boiler house, to the oil burners. Each pump is supplied with an oil-heating tank containing coils through which the oil is forced in pumping, steam being admitted to the tanks to the outside of the coils. This heats the oil and makes it more convenient to handle through the pipe line and to the burners.

An interesting pipe-line installation between the main storage tank and the one at the boiler house has been made, consisting of the oil line and a steam line, Fig. 3, running together through a conduit, the two pipes being surrounded by a sheet-metal jacket, Fig. 5, to act as a heating chamber. Both pipes are placed in a J. M. conduit, and asbestos sponge fillings are placed around the heating chamber, which is between the sheet-metal jacket, as shown by Fig. 6, and the tile waterproofing covering, Fig. 7.

Expansion and contraction are taken care of by supporting the pipes on roll frames placed on 12-ft. centers, Fig. 3. These frames carry the pipes independently of the tile, and the insulation is the only weight resting on the tile.

So far as known this installation is the first of its kind; that is, it is the first time conduit has been put in use as a fuel-oil carrier. The pipe line is constructed under the sidewalk and manholes are provided at intervals.

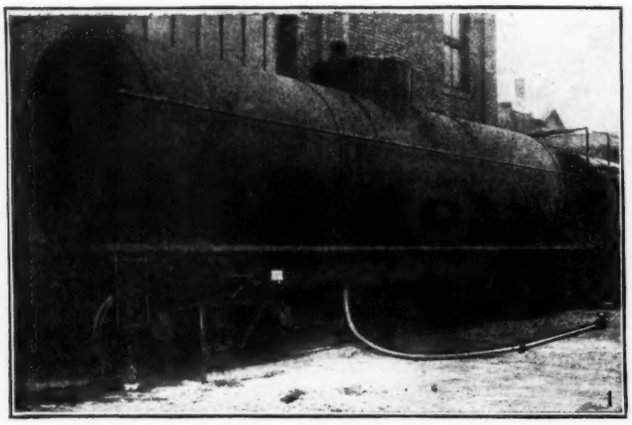

FIG. 1. TANK CARS BEING UNLOADED

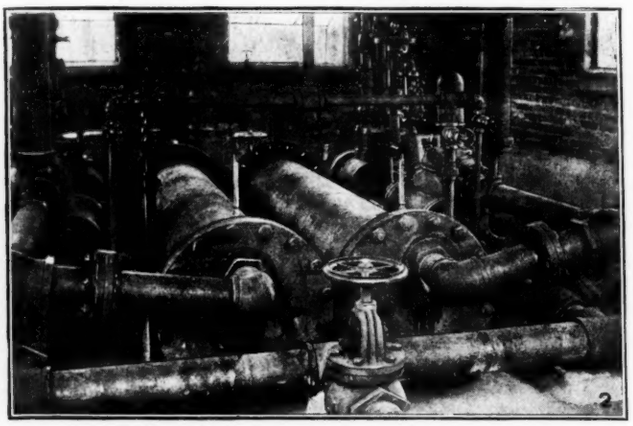

FIG. 2. FUEL-OIL PUMPS AND OIL HEATERS

FIGS. 3 TO 7. DETAILS OF PIPE CONDUIT LINE

Fig. 3—Bottom half of conduit and roll frame ready for piping. Fig. 4—Oil and steam pipe line on roll frame. Fig. 5—Applying sheet-metal jacket around oil and steam lines to act as a heating chamber. Fig. 6—Top of conduit being applied and conduit felting placed around the heating chamber. Fig. 7—Finished job showing cemented waterproofed bell joints.

Power Plants of the Morris & Essex Canal

By Hugh G. Boutell

To anyone interested in the historical side of engineering and similar work, some of the towns of northern New Jersey, situated only a short distance from New York City, contain many objects worthy of investigation. During a recent visit in that neighborhood I was particularly impressed with the elaborate works connected with the old Morris & Essex Canal. Much of this construction is naturally of the greatest interest to the civil engineer, but some of it will appeal to the mechanical man as well.

This canal was built during the period between 1824 and 1835, and connects tidewater at Jersey City with the Delaware River at Easton, Pa., about 102 miles away. The primary object of its construction was to furnish a cheap means of transportation from the Lehigh Valley region to New York City. The route selected gives to the canal a total rise and fall of 1,674 ft., since the summit level is 914 ft. above Jersey City and 760 ft. above Easton. To overcome this grade 23 inclined planes and 23 locks have been provided.

The locks present no features of particular interest, but the planes, to me at least, appear to be unique. Both single and double planes are used, depending on the location and, I suppose, the density of traffic, though this latter point is now hardly worth considering. The planes consist of a single or double line of rails, so arranged as to pass over the summit and dip into the water at the high level of the canal and into the low level at the bottom. On this track run two cars or cradles, constructed of heavy timbers, The cars are permanently coupled together and rest on a large number of small flanged wheels. The track is laid with rails of a long-ago obsolete cross-section, to a gage of

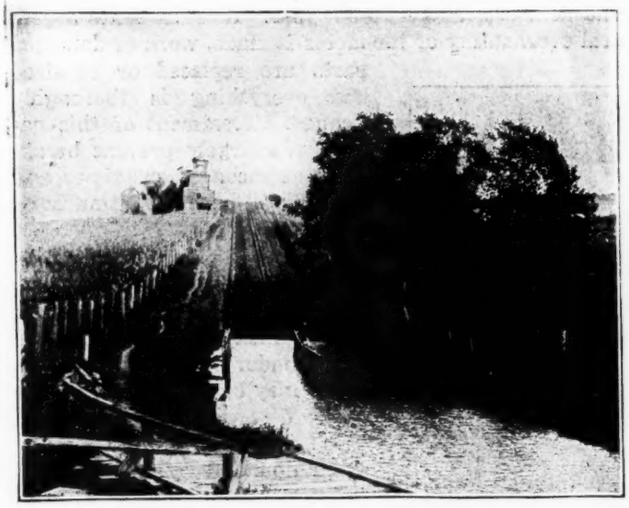

FIG. 1. VIEW LOOKING UP ONE OF THE DOUBLE PLANES
The cars on the left-hand track are in the water at the low level.

about twelve feet. Each rail is carried by a heavy wooden stringer made fast to the roadbed. The cars are raised and lowered on the plane by a wire rope, about 2½ in. in diameter, supported by sheaves in the middle of the track.

The "power plants" used for operating this hauling rope are most interesting. They are all more or less similar in construction and each one consists of a large drum, 12 ft. in diameter, over which the rope is wound, and which is driven by a vertical, low-head water turbine. This turbine runs, of course, always in one direction, but by means of a clutch controlled by the operator the motion of the winding drum may be reversed. Water for the turbine is conducted from the upper level of the canal by means of a rectangular wooden flume to a cir-

FIG. 2. VIEW OF PLANE, SHOWING WHEELHOUSE AND FLUME
The cars are controlled from the upper room.

cular, vertical wooden pipe near the wheelhouse, where it drops to the pit in which the turbine is placed. After operating the turbine, the waste water flows into the lower level of the canal. Most of the machinery in connection with these planes, while not that originally used, was constructed prior to 1860, but it appears to be in good operative condition.

The illustrations give a good idea of the appearance of one of these plants and the plane which it operates, near Easton, Pa. The long horizontal flume, the quaint old wheelhouse and the plane itself are all distinctly shown. The wheelhouses that I have seen were all built with at least two stories above ground; from the upper one the motion of the drum was controlled, thus giving the operator an unobstructed view of the plane.

When it is desired to pass a canal boat up or down the plane, the boat is floated onto the cars, made fast by ropes to cleats placed along the sides of the latter and either raised or lowered on the plane till the boat again floats at the new level. The system appears to possess advantages over the ordinary locks, for while the boat is being raised or lowered it is also going forward at about the same rate of speed as is maintained on the level portions of the canal. Thus less time is required to make the passage, and I imagine the water consumption of the turbines is less than would be the case with locks.

While the canal is still maintained in running condition, it is seldom used, having been unable to satisfactorily compete with the railroads. The planes are grass-covered, and spiders have endeavored with their tiny threads to prevent the motion of the cars upon the old rails, but even in their present condition the works are impressive and stand as a monument to early American skill and ingenuity.

Treatment of Direct-Current Motors for Mining Conditions

Motor Troubles Inherent to Mining Conditions—Combating Moisture Troubles by Making Windings Moisture-Proof—Dipping Tank Made from 50-Gal. Oil Drum—Bake Oven Constructed from Gas Scrubber—Dipping and Baking Process Described in Detail

By T. H. ARNOLD
Electrical Engineer, Mining Department, Arizona Copper Company, Limited

IN MINES where 250-volt trolley haulage is used the trolley wires and direct-current feeders are well distributed over the property, both on the surface and underground. Power may be conveniently obtained by tapping the feeders or trolley for the motors which operate small pumps, ventilating fans, small hoists, concrete mixers and for the numerous other small-power uses to be found around such applications. For the large hoists and pumps and for the heavy and more important drives special feeders must be run, and it is usually more economical to install alternating-current motors of somewhat higher voltage.

Moisture, Dirt and Neglect the Principal Causes of Trouble

Direct-current motors, especially the older types, have many troubles which are common to mining conditions. The main troubles encountered are due to moisture, dust and neglect. Motor equipment of a mine is much more scattered than is usual in other industries, and unless considerable supervision is exercised it is likely to be neglected. When a man has to climb a hundred or two feet of ladders to inspect a motor, he is prone to make his inspection by proxy. Dust causes trouble in bearing lubrication, heating and commutator trouble. The last may be due to abrasive dust cutting the commutator or to brushes wedging in the holders. Cleaning the motors frequently with compressed air and washing out the bearings is the only remedy.

Moisture trouble is more serious—it causes a partial or general failure of the insulation, resulting in burned-out coils or grounded commutator. It may be due to absorption of moisture from the atmosphere, to drip from the roof or to total immersion from flooding. If a motor is installed in a humid atmosphere, it should be operated sufficiently to keep it dried out. Temperature changes from changing air currents may cause the motors to sweat. An endeavor should be made whenever possible to locate the motors in places known to be dry. This, however, is frequently difficult; the damp portions of a mine will often shift with the progress of the ore removal.

The most practical place for combating troubles due to moisure is in the shop. All parts of the motor should be made as nearly moistureproof as possible by a thorough dipping in insulating compound and baking of the current-carrying parts. This method of treatment has several distinct advantages. A thorough dipping, followed by suitable baking, will fill the pores and openings and render the coils and commutator ends impervious to moisture, thus preventing insulation breakdowns. It prevents loosening and movement of the coils and band wires by swelling and subsequent drying out of the insulation. By filling the air pockets it enables the heat to be dissipated more readily. Cementing the wires together will prevent movement and chafing of the insulation. The coil leads will be stiffened and will not crystallize so readily at the commutator necks. The insulation in general will withstand damage from mechanical injury much better, as the coil will be practically a solid mass.

FIG. 1. DIPPING TANK MADE FROM OIL DRUM

Dipping and Baking Armatures and Field Coils

The street railways and traction companies have realized for some time the savings resulting from regular and systematic dipping and baking of armature and fields coils. A complete equipment for this purpose is considered a necessary part of the shop outfit. The general custom is to remove, dip and bake armatures and field coils about once a year. At such times a general overhauling of the motor is made, worn or damaged parts are replaced or repaired and everything is thoroughly cleaned. Treatment of this nature will largely prevent breakdown at inconvenient times and will greatly benefit continuity of service.

Very few mining companies have equipment of this nature, and a brief description of a rather inexpensive outfit installed under the direction of the writer may be of benefit. It will handle direct-current armatures up to 25 hp., and larger ones may be manipulated by dipping one end at a time. Second-hand material was used largely, thus the cost was low, being principally for labor. It can be readily duplicated at almost any mining property.

The dipping tank, Fig. 1, was constructed from a 50-gal. oil drum. One head was cut out completely to give the maximum diameter of opening. In order to reduce the total amount of

varnish necessary to completely cover the armature a piece of 4-in. pipe 14 in. long was placed in the center of the drum, at the bottom, for the shaft. The space between the pipe and the drum was then filled with concrete. This extra weight also prevents the tank from being readily upset. To prevent the evaporation of the volatile ingredients of the varnish a 2 x 2-in. sheet-iron trough was placed around the top of the drum. A sheet-iron cover fits over the top and rests in the trough. The trough is filled with water, thus sealing the joint of the cover. In order to move the tank more readily it was mounted on a truck made by bolting 4-in. malleable casters under each corner of a piece of ⅜-in. steel plate. The tank is run under the crane when dipping and draining an armature and stored in an out-of-the-way place when not in use. As usual with electrical repair shops, floor space is at a premium.

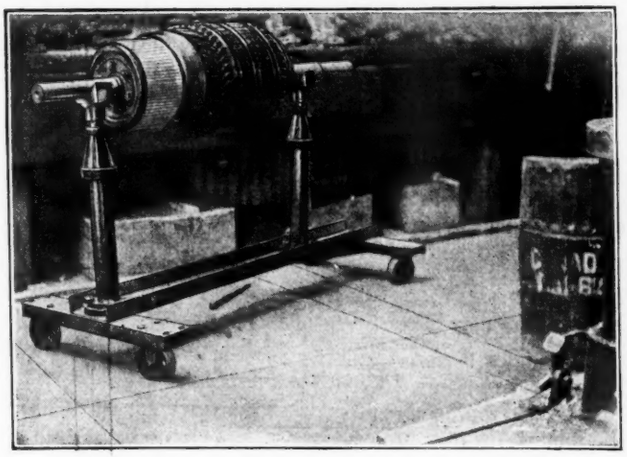

FIG. 2. ADJUSTABLE STAND FOR ARMATURES

How the Baking Oven Was Made

The baking oven was made from a gas scrubber taken from an abandoned gas plant. It was of ample size to accommodate several armatures and happened to fit in a particular space in the shop which could be spared. It is constructed of ¼-in. sheet iron, and no attempt was made to insulate the sides. The door is held in place by bars which drop into wedging catches, the weight of the door forcing it into contact with the face of the oven. Heat is produced by open coils of No. 14 Nichrome wire supported on No. 4 porcelain knobs. To maintain a temperature of 90 deg. C. a current of 25 amperes at 250 volts is required. While lagging the oven would reduce the amount of power required somewhat, this was left for the future. Ventilation is secured by openings in the sides and top, and also by leakage around the door. The gases from the insulating compound are highly inflammable and considerable ventilation is advisable to insure safety from fire. Suitable supports are riveted to the sides and top for supporting coils and small armatures. Large armatures are rolled in on the armature stand and baked on the latter.

The Armature Stand

The armature stand, Fig. 2, was constructed from channel iron and pipe fittings. It is adjustable in height and length to cover a wide range. As it is mounted on casters it is readily moved about the shop. This enables an armature to be placed on it under the crane and then run into the winding room. Much heavy lifting is avoided in this manner, and one crane serves several purposes. When movement of the stand would be objectionable it can be bolted to thimbles set in the floor. The V-blocks are swiveled on the heads of the screws, thus enabling them to be adjusted to height with an armature in place. To remove a commutator from a large armature, the armature is blocked for height and the screw lowered out of the way. When the work is completed the screw is raised and the blocking removed. This apparatus is designed to be operated as much as possible by one man. After an armature or field coil has been rewound, repaired or thoroughly cleaned, as the case may be, it is heated to 90 deg. C. for two hours or longer to dry it out thoroughly. This heating also enables better penetration of the dipping varnish. The armature is then placed, commutator end down, in the dipping tank with the coils submerged and allowed to soak in the varnish till all evidence of bubbling has disappeared. It is then raised out of the tank and allowed to drain till all excess varnish has dripped back into the tank, and is then placed in the oven and baked. Small armatures are placed in the oven with the shaft vertical to prevent the varnish settling to one side during baking. Large armatures are placed with the shafts horizontal and are turned from time to time. The baking time is usually about eight hours, but is sometimes increased for large armatures. Oven temperature is maintained at 90 deg. C. While higher temperatures and longer periods are sometimes recommended we have found these to give good results for our conditions. After removal from the oven the armature is allowed to cool, excess varnish is cleaned from the shaft and commutator; the latter is then turned down and the mica undercut. The armature may now be put back into service or be stored until such time as it is required to replace one that has failed.

Nicely Finished Apparatus Usually Well Cared for

Field coils are removed from the machine, dipped and baked in a similar manner. While this process is going on the rest of the motor is given a general overhauling and the frame is painted with an engine enamel. The latter has a purpose other than the protection it affords. A well-painted motor is easier to keep clean. It is also a psychological fact that the average man will pay more attention to keeping a nicely finished piece of apparatus in good condition than one which externally looks as though it was ready for the scrap heap.

A satisfactory varnish for the purpose is a linseed-oil base of rather thin consistency. This varnish is selected as it does not dry out hard, but will retain its flexibility after exposure to considerable heat. It is also not affected by oils or water, which is one of the most important considerations around a mine.

Motors given this treatment will withstand a surprising amount of abuse and rough treatment. It appears to be inherent in mining to expect a machine to stand up and run satisfactorily under conditions that would be considered beyond all reason in other industries. It therefore behooves the electrical department to make the electrical equipment as nearly indestructible as possible, and it has been my experience that the treatment described in the foregoing helps materially.

The Steinbecker Oil Engine

The attention that has been given to the solid-injection oil engine is due to the design eliminating the employment of the injection air compressor. This reduces the cost of the engine, which in all other respects is fully as expensive as the Diesel, by at least 20 per cent. An engine that makes use of the solid-injection principle, but with important modifications, is the Steinbecker four-stroke-cycle oil engine recently introduced in Germany, and described in *Gas Engine*.

In Fig. 1 appears an outline of the fuel pump and combustion retort of this engine. The retort *A* is in communication with the engine cylinder through the passage *B*. On the compression stroke air is forced through *B* into the cavity *A*. Just before top dead center the fuel pump forces a small amount of oil into the passage *B*. This fuel is picked up by the air passing into the retort. The mixture of air and oil particles explodes, increasing the pressure existing in *A*. The direction of the air currents along the passage *B* is reversed, and the charge of burnt gases starts to flow from *A* into the engine cylinder. The fuel pump continues to force a stream of oil into the passage; this oil is picked up and atomized by the currents of burnt gases. The fuel is carried into the engine cylinder, and combustion occurs.

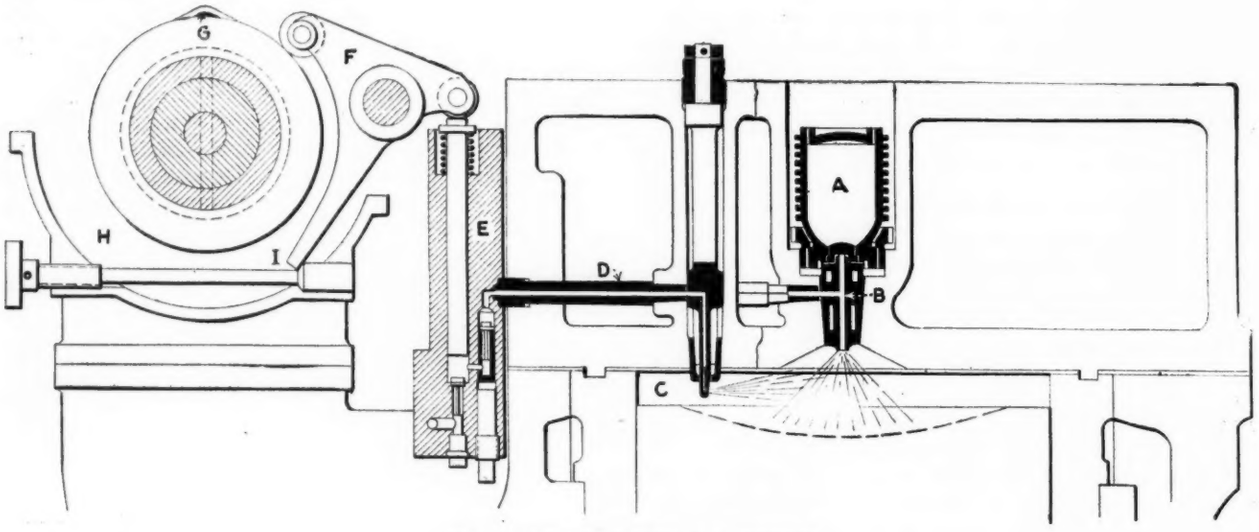

FIG. 1. STEINBECKER OIL ENGINE

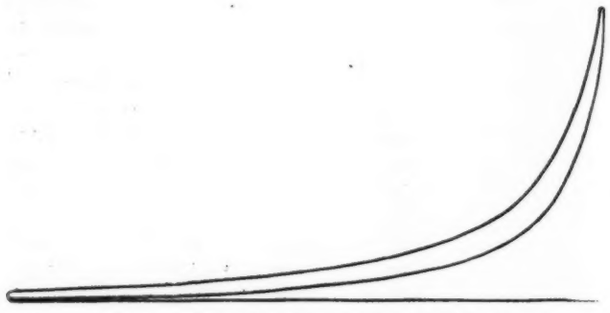

FIG. 2. NO-LOAD INDICATOR DIAGRAM

In the later developments of the engine a secondary fuel nozzle is placed at *C*. The fuel entering the cylinder from the passage *B* then provides the initial ignition, while the main charge enters at *C*. To provide against pre-ignition of the charge in *A*, the retort is water-cooled and provided with radiating fins. Indicator cards showing no-load and full-load conditions are shown in Figs. 2 and 3. It would appear that any variation in the characteristics of the fuel would seriously affect the timing of the explosion in the retort *A*. Unless some method is provided for the thorough scavenging of the retort after combustion takes place, there would probably be a tendency toward misfires under low-load conditions. The design is in many respects a development of the Hvid or Brons principle with the addition of a timing of the fuel introduction.

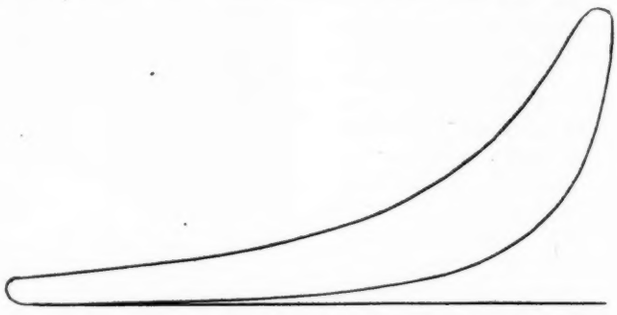

FIG. 3. FULL-LOAD INDICATOR DIAGRAM

The heaviest circuit breakers ever designed for 13,200-volt service will be installed by the United Electric Light and Power Co., New York, in its Hellgate Station. There will be 120 of these solenoid-operated type 04 Westinghouse circuit breakers having an interrupting ability of 58,000 amperes at the arc (1,500,000 kva.). The disconnecting switches are gang-operated, and their operating mechanisms are interlocked with the oil-breaker mechanism so that the disconnects cannot be moved unless the breaker is not in the operating position, thus assuring safety to operators. These oil breakers are unique in that the phase elements will be in separate rooms approximately thirty feet apart.

Improved Operating Conditions Save $13,585 in Fuel per Year

BY OLLISON CRAIG, M.E.*

An investigation of the operating conditions of the Buhl, Minn., power plant revealed that a number of factors were responsible for the waste of fuel, such as leakage of air past the dampers of stand-by boilers; contracted breeching area with soot and ash; damper not used, inattention to draft control; holes in fuel bed; open furnace doors; soot on boiler heating surface; low combustion rate; too many boilers in operation and improper management. All of these conditions were easily remedied, resulting in the saving of $13,585, based on the price paid for coal.

IN AUGUST, 1919, the village of Buhl, Minn., requested the Charles L. Pillsbury Co., consulting engineers, of Minneapolis, to make an investigation of the Buhl municipal power plant and to report on the conditions found and the things that should be done to secure economy of coal consumption. The plant had burned, the previous year, 8,100 tons of coal, costing about $8 a ton. After investigation an arrangement was entered into whereby a monthly inspection was made of the plant and a check kept on the operating records, to insure that the recommended changes were put into practice and to determine the results of these changes.

The principal equipment of the plant consists of one 18 x 24-in. non-releasing Corliss engine, 200 r.p.m., direct-connected to a 250-kw. 2,400-volt 60-cycle three phase a.-c. generator; one 13 x 24-in. four-valve engine, 275 r.p.m., direct-connected to a 75-kw. 2,400-volt 60-cycle three-phase a.-c. generator; one 14 and 16 by 10 and 16-in. tandem steam-driven air compressor; three 150-hp. return-tubular boilers, equipped with stokers; one 350-hp. horizontal water-tube boiler, equipped with a stoker; one 350-hp. cross-drum, vertical water-tube boiler, equipped with a stoker, and one feed-water heater and V-notch meter, having a capacity of 45,000 lb. of water per hour.

A concrete stack, 60 in. inside diameter by 185 ft. above the line of the grates, serves all the boilers. Coal is weighed in cars of about one-ton capacity each, which cars are elevated to a light track running over the stoker hoppers. From this track the coal is dumped and distributed to the various hoppers.

The plant supplies heat, light, power and water to the village. The bulk of the steam produced during the year, however, is used for heating, as all the homes, business buildings and public buildings in the village are supplied with steam from the municipal plant for heating. There was not, so far as could be learned, an individual heating plant in the town. During the summer exhaust is turned into the mains, supplying customers with steam for use in hot-water tanks. The electric power generated is used principally for internal lighting, street lighting and cooking, the street lighting producing a peak electrical load for a few hours in the evening. The air compressor is used for lifting water from a deep well into a reservoir at ground level, from which it is elevated into a steel tank by electrically driven centrifugal pumps.

The investigation was made to determine those conditions of equipment and of operation which were wrong and to collect data on which to base recommendations for corrective measures.

RESULTS OF THE INVESTIGATION

It was found that the boilers were being operated far below rating, the load varying from 30 per cent to 140 per cent of rating. The average for the previous year was 75 per cent. To show the effect of operation below rating, two evaporative tests were made. At the time of the investigation two 150-hp. boilers were being operated. The first test was made with these two boilers in operation, and the second with only one 150-hp. boiler in operation. The first test showed a steam production of 56.7 per cent of rating and an evaporation of 6 lb. of water per pound of coal; the second showed a steam production of 126 per cent of rating and an evaporation of 8.5 lb. of water. The CO_2 in the flue gases in the two cases was, respectively, 4.4 and 13.7 per cent. In the first case the amount of grate surface in use was so large that for the greater part of the time it was practically impossible to keep it covered with fuel. This accounts for the low CO_2, and the low CO_2 in turn indicated a large loss of the heat generated up the stack.

Certain other errors of operation were found which entered into the results of the tests. The firemen made no use of the dampers. If the steam demand dropped and the safety valves blew, they opened the furnace doors. During the second test, when such a condition occurred, the damper was throttled. The amount of air passing through the furnace was thereby reduced instead of increased, and consequently the amount of heat carried out the stack was reduced. Attention was also given, during the second test, to the bed of fuel, to prevent the formation of holes; and the damper was regulated by the use of a draft gage to control the supply of air in accordance with the demand.

The dampers of all boilers were found to be stuck in place; that is, in open positions. The breeching was faultily designed, there being one sharp bend around which one-third of the available stack draft was lost. The breeching was found to be badly filled with soot and fly ash. These things tended to reduce the amount of draft available in the furnaces, and in turn the amount of air supply and the amount of coal the furnaces could burn. The sharp turn consumed a large amount of draft pressure by causing eddy currents. The clogging of the breeching by soot and fly ash increased the friction loss by increasing the velocity of the gases. The dampers being open in stand-by

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boilers reduced the stack draft by diluting the stack gasses with cold air and reducing the stack temperature, which was found to be as low as 200 deg. F.

The setting of the boilers was found to be quite good, the brickwork having been covered with a plastic coating to prevent the infiltration of air. The water side of the boiler tubes was in good condition, the boilers being washed with fair regularity and boiler compound having been used effectively. The fire side of the boiler tubes, however, was badly caked with soot. The only tube-blowing equipment was a hand lance, and blowing was not done effectively or with sufficient frequency.

At the time of the investigation the power-plant operators thought that the load could not be carried with one boiler, since the air compressor was quite often in operation during the evening hours while the peak electrical load was on. It was their opinion that this caused a demand for steam that was too great for one boiler to supply. The air compressor was in operation about 14 hours of each 24 hours, for pumping water into the reservoir. The peak boiler load resulting from the operation of this compressor during the peak electrical load existed only from two to three hours each evening. It was obviously possible so to control the periods of operation of this compressor, while still keeping sufficient water in the reservoir, that its operation during the period of peak electrical load could be stopped, thus avoiding the extreme peak of steam demand which required the operation of two boilers.

The principal factors in the waste of fuel in the plant were: Leakage of air past dampers in stand-by boilers; contraction of breeching area by soot and fly ash; sharp bend in breeching; dampers not used; attention not given to draft; holes in fuel bed; open furnace doors; soot on boiler heating surface; low combustion rate; too many boilers in operation and improper management.

Recommendations Submitted

A report was submitted covering the causes of fuel loss and containing recommendations for corrective measures. The report contained curves showing the records of plant operation in graphic form for the preceding year. Curves were included showing the boiler horsepower in operation, the percentage of rating developed, the evaporation per pound of coal, and the relation between the rating developed and the evaporation per pound of coal. The latter curves indicated quite distinctly that better evaporative results had been secured in the past with heavily loaded boilers, than with lightly loaded boilers. The results of the two tests were also cited to add emphasis to the comparison of operating conditions and to the recommendations.

The recommendations which were particularly emphasized were as follows:

The rate of combustion per square foot of grate surface should be increased. An average of 20 to 25 lb. of coal should be burned per square foot of grate surface per hour instead of the actual average of 13 lb. To effect this, fewer boilers should be operated. The horsepower developed should be 130 per cent of rating instead of the actual average of 75 per cent developed.

Dampers in all boiler uptakes should be put in operating condition. Dampers on stand-by boilers should be kept closed. Draft gages should be installed, and dampers on the boilers in operation should be regulated by the use of the draft gages to control the supply of air according to the requirements for combustion.

Strict attention should be given to the fuel bed to keep it even and free from holes.

The practice of opening furnace doors to reduce the rate of steam production, when the safety valve blows, should be discontinued. The dampers should be throttled instead.

The breeching and gas passages should be kept free of soot accumulations. Flues and tubes should be effectively blown at least once each eight-hour shift, and preferably with permanently installed tube blowers, rather than with a hand lance.

The equipment in the plant, so far as possible, should be operated to make the boiler load as even as possible.

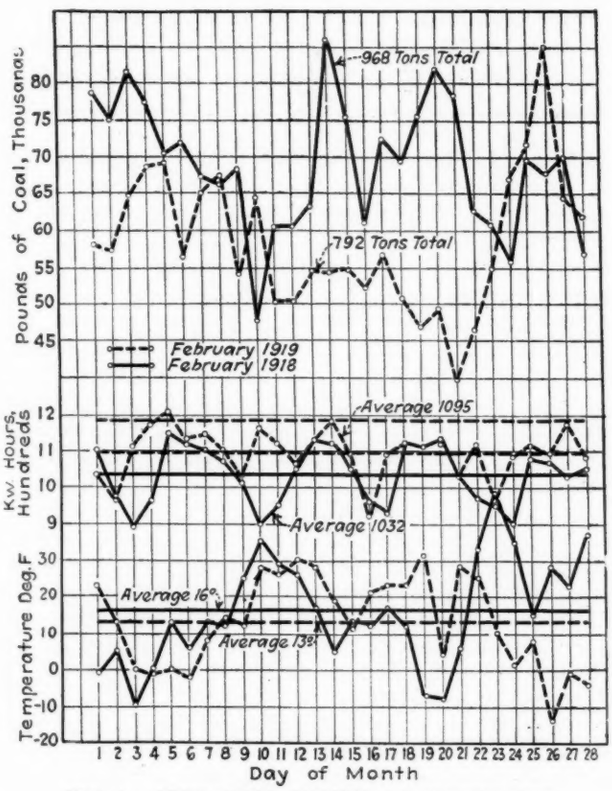


FIG. 1. OPERATING CURVES COMPARED FOR FEBRUARY, 1918-1919

This applies particularly to the operation of the air compressor.

Flue-gas analyzing equipment should be used with sufficient frequency to determine the variation of CO_2 in the flue gases and to determine whether the coal is being burned efficiently or inefficiently.

Monthly Inspections Were Made

After the report was submitted, an inspection was made of the plant each month. Particular attention was given to operating conditions at the times of inspection. Each month the operating data were plotted into curves and curves for the same month of the previous year were superimposed for comparison. Fig. 1 shows the curves for February, 1919, in dotted lines; the curves for February, 1918, being superimposed in solid lines. For this month the total coal consumed

was 792 tons in 1919, as compared with 968 tons in 1918. The kilowatt-hours produced were 33,200 in 1919, as compared with 2,900 in 1918, and the outside temperature averaged 13 deg. F. in 1919, as compared with 16 deg. in 1918.

These curves, together with an analysis of the operating data for the month and a comparison of the

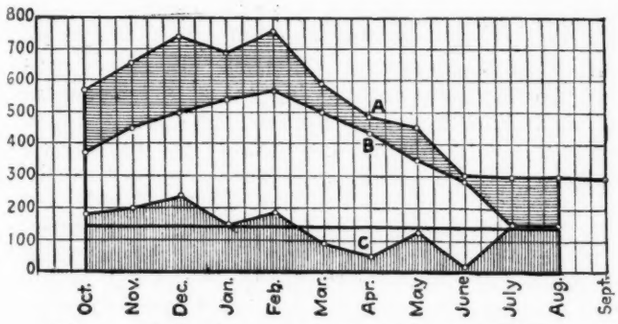


FIG. 2. AVERAGE RATED BOILER HORSEPOWER MONTHLY CURVE, YEARS 1917, 1918 AND 1919

operation with the same month of the previous year, were incorporated into a monthly inspection report. This report also included the result of the plant inspection.

The inspections and reports served to keep a check on the plant and to keep the Village Water and Light Board informed as to its operating and physical conditions. The monthly inspections also made it possible to get put into effect recommendations that might otherwise have been neglected and to keep the plant operatives interested in fuel saving.

Fig. 2 shows the average rated boiler horsepower in operation each month, curve *A* being for 1917-18 and curve *B* for 1918-19; curve *C* indicates the difference, or reduction. The average reduction was 146.3 hp., or practically equivalent to cutting out one of the 150-hp. boilers.

Fig. 3 shows the total coal consumption per month, the saving in coal, the average kilowatt-hours generated per day for each month and the average outside temperature for each month. In this figure curve *A* shows the actual coal consumption per month for 1918-19; curve *B* the consumption for 1917-18 and curve *C* the consumption for 1917-18 corrected for operating conditions, or service performed, during 1918-19. Curve *D* shows the percentage of saving in coal, or the per cent difference between curves *A* and *C*.

In order to make a comparison of coal consumption, it was necessary to make corrections for the service performed. Fig. 4 shows a curve with average monthly outside temperatures and total monthly coal consumption as co-ordinates. After making corrections in the coal consumption for February, 1919, for the number of days in the month, and for March, 1919, for gross inefficiency due to fallen furnace arches, the points fall quite close to a straight line. The slope of the line gives the change in coal consumption per month for a change of one degree in outside temperature. The amount indicated by the curve is 14,000 lb. Each month during the heating season, then, the coal consumption for the same month in the preceding year was increased or decreased by the product of the difference in temperature between the two months and 14,000, according to whether the temperature was lower or higher. This correction was possible, since during the heating season practically the entire steam production, including both the live steam and the exhaust, was used for heating purposes. A correction was also made for increased radiation. During the non-heating season a correction was made, based only on the per cent difference in electrical output, on the assumption that the variation in plant service was represented by this difference. Curve $C + 193$, then, represents the amount of coal that would have been consumed in 1917-18 if the service delivered had been the same as in 1918-19. The difference between curves *A* and *C* represents the true saving in coal as nearly as it was possible to determine.

The net results were: A reduction of one 150-hp. boiler in the boilers operated; an actual reduction of

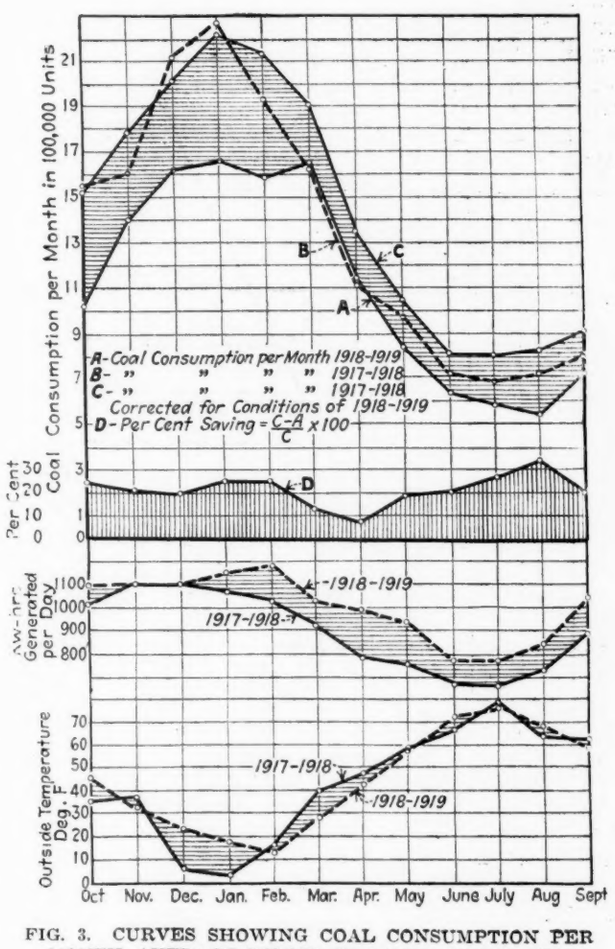

Consumption per Month in 100,000 Units
A-Coal Consumption per Month 1918-1919
B- " " " " 1917-1918
C- " " " " 1917-1918
Corrected for Conditions of 1918-1919
D-Per Cent Saving = C-A/C x 100
Per Cent Coal
Kw-hrs Generated per Day
1918-1919
1917-1918
Outside Temperature Deg. F.
1917-1918
1918-1919
Oct Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug Sept

FIG. 3. CURVES SHOWING COAL CONSUMPTION PER MONTH, AVERAGE KILOWATT-HOUR GENERATED PER DAY, PER MONTH AND AVERAGE OUTSIDE MONTHLY TEMPERATURE

1,270 tons of coal with an increased service output; a net saving of 1,842 tons of coal on the basis of the same service output; a net saving of 21.2 per cent of coal consumed during the year of inspection, on the basis of the same service output and a net saving of $13,585, based on the price paid for coal.

The Buhl plant is typical of a large number of plants. Some or all of the conditions that existed could be found in most plants, and most plants could make a decided reduction in coal consumption as easily as was done at Buhl.

Weighing the coal fired and the water fed will give an average indication of the over-all efficiency of a boiler plant, but if the ratio of water to coal is low, other means must be taken to locate the cause of the inefficiency. In most cases some one or more of the conditions enumerated will be found as the cause of high coal consumption, and these conditions should be searched for in detail.

In the operation of any boiler the big loss of fuel is through the loss of heat up the stack. This loss, in general, may be divided into two parts—excess of air and inefficient heat transmission. If more air is passed through the setting than necessary for combustion of the fuel, this excess air performs no function other than to carry away heat that would otherwise be available for making steam. If the transmission of heat is inefficient, the gases of combustion will pass the heating surfaces without transferring all the heat available for transmission.

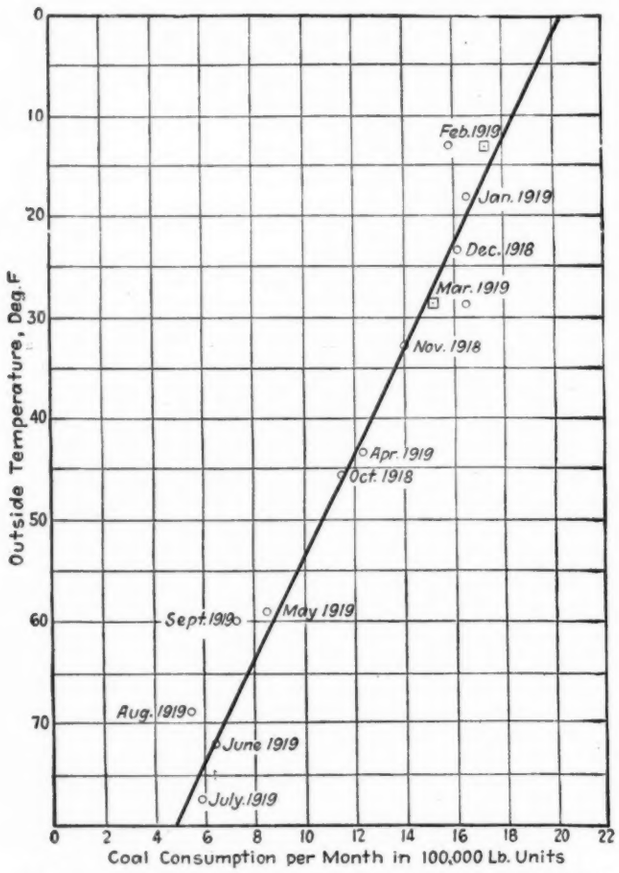


FIG. 4. AVERAGE MONTHLY OUTSIDE TEMPERATURE AND TOTAL MONTHLY COAL CONSUMPTION AS CO-ORDINATE

The excess air may be detected by determination of the CO_2 in the flue gases. Roughly, the flue gas will contain from 19 to 20 per cent of CO_2 when burning bituminous coal and containing no excess air. If the CO_2 should be 10 per cent, there would be, roughly, 100 per cent of excess air, and if the CO_2 should be 5 per cent, there would be approximately 300 per cent of excess air. About 12 lb. of air is required to burn 1 lb. of bituminous coal. If the CO_2 should be 5 per cent, about 36 lb. of excess air would be passing through the setting and carrying away heat. If the flue gases were 500 deg. higher in temperature than the entering air, the heat lost would be, roughly, $36 \times 500 \times 0.25$ or 4,500 B.t.u. for each pound of coal burned. The actual stack loss would be one-third greater, or 6,000 B.t.u., the 4,500 B.t.u. being the heat carried away by the excess air alone.

Practically, some excess air is necessary in order to secure proper combustion, but 15 per cent CO_2 should be set as an approximate standard. Most plants are getting the 5 per cent.

If the flue gases are passing out at a temperature 600 deg. above that of the entering air and the temperature can be reduced 100 deg., 17 per cent of the stack loss can be saved. This would represent a saving in coal of 4 or 5 per cent if the CO_2 was 10 per cent.

A flue-gas analyzer will tell when there is an excess of air, and a flue thermometer will tell when the temperature of the gases is too high. If the CO_2 is low, the cause may be holes in the fuel bed, improper damper regulation, leaky setting or too light a fire. If the boiler is heavily loaded, there is less possibility of a light fire or of holes in the fuel bed than if lightly loaded. This is one reason for operating boilers above rating. If air leaks or contractions or impediments in the breeching reduce the draft in the furnace, sufficient coal cannot be burned to operate the boiler at economical capacity. Frequent analyses should be made of the flue gases, and if the CO_2 is low, the possible causes should be checked and the necessary corrections made. For the purpose of firing operations a CO_2 recorder is preferable to a hand instrument. If the use of a flue thermometer shows a high temperature of flue gases, the heating surfaces are not clean, assuming that the boiler is of proper design. Care should be taken to keep soot and ash accumulations from one side and scale from the other.

There are a large number of possible losses that this discussion has not considered, but if use is made of a flue analyzer and a flue-gas thermometer, the CO_2 kept between 10 and 15 per cent, and the stack temperature kept down to 500 or 550 deg., the bulk of the losses experienced in the average plant will be recovered.

Suggestions for the Semi-Diesel Engineer

If the crankcase is not kept drained of lubricating oil, the engine may run away when the load is thrown off. The oil will be carried into the cylinder by the scavenging air.

When a heavy fuel oil is used, a considerable residue will drip down into the crankcase of vertical engines. If this tarry substance is not removed, it will work into the crankpin oiling device. Many crank brasses are ruined because of this carelessness.

On two-cycle engines the piston-pin brasses wear as rapidly as do the crankpin bearings. The former should be adjusted as frequently as the latter.

The piston-pin setscrews often work loose. If the pin is allowed to shift sideways, the cylinder walls will be scored.

In some engines a brass scraper is placed in the end of the piston pin. The scraper picks up the lubricating oil from the cylinder wall and forces it through a passage onto the piston pin. This scraper often becomes choked with tar. It should be cleaned very frequently.

EDITORIALS

Is the Purveyance of Coal a Concededly Private Industry?

LAST July the legislature of Indiana awoke to the fact that a sure and plentiful supply of food and fuel is one of the first requirements of contentment, security and well being, the assurance of which is a proper and legitimate activity for a people in its collective capacity, and appointed a Coal and Food Commission.

This commission was given the power, among other things, to regulate and fix the price at which all coal moving in intrastate commerce in the State of Indiana shall be sold to jobbers, wholesale and retail dealers and to the general public, just as a public utilities commission fixes the price at which gas, water, electricity and transportation shall be sold.

The day when regulation of public utilities was proposed is not so long ago that the storm of protest against such interference with "private industry" will be forgotten. The lucubrations of journalistic champions of those interests against the great proposer of these progressive policies are blots upon their editorial pages that the subsequent vindication of Roosevelt and government regulation have made odious. The utilities themselves now admit the justice and desirability of intelligent regulation which will insure the stability of their properties, a fair return upon the investment in them and service to the public at cost plus a fair profit.

Is the mining and distribution of the fuel resources of the country any less a matter of public concern than furnishing its light, power, water and transportation?

Is the administration of the fuel supply, upon which all these utilities as well as most of the basic industries of the country and the health and comfort of the people depend, "a concededly private industry"?

An injunction suit was filed in August last against the Commission in the United States District Court at Indianapolis by which it was sought to test the power of the State of Indiana to regulate its coal industry in the manner contemplated by the legislature. In discussing the court's dismissal of the application for injunction, Rush C. Butler, general counsel of the National Coal Association, says in a recent issue of the *Coal Review*, the organ of the Association:

> The interesting and at the same time the alarming feature of the opinion of the court is that while no state in the United States has heretofore attempted any such regulation of a *concededly private industry*, it is apparent that the exercise of price-fixing and other regulatory powers by the Federal Government during the war has made such an impression as to lead the court seriously to consider whether the exercise of those powers by the several sovereign states during times of peace may not be nothing more than the exercise of the portion of the police power not delegated by the states to the Federal Government.
>
> Perhaps I should not have used the word "alarming" in speaking of this opinion, for, after all, the laws which govern us, whether municipal, state or Federal, merely reflect the mind and will of the people and the courts' duty is merely to interpret and apply these laws.
>
> Accordingly, if it is the will of the people that such laws be enacted, it is clearly within their power, by constitutional amendments if not otherwise, to authorize the enactment of statutes similar to the one referred to. However, the opinion of the court may well give alarm to the coal industry if for no other reason than that that industry and no other is singled out for price-fixing and regulation in this particular piece of legislation.
>
> It is understood that the case will be carried directly to the Supreme Court of the United States and that the power of the state to enact such legislation will be vigorously contested.

Electrical Maintenance and Continuity of Service

CONTINUITY of electrical service first became a factor in the operation of large power systems, but has gradually spread into every branch of power distribution and utilization. As industrial processes become more highly developed and more dependent upon the application of power, the necessity of reliable power service in every department of the manufacturing process has become, in many cases, almost imperative. Failure of motors is almost as serious as failure of the main generating units.

By careful study of industrial needs manufacturers have done a great deal in the development of reliable electrical equipment in almost every branch of industry. However, this is only one-half of the story—what is of equal importance is the installation and maintenance of the equipment. If electrical machinery is to obtain the proper care, it is essential that it be installed where it can be given attention by the maintenance men. To install a motor in some location where the attendants must run the risk of injury every time they inspect or make adjustments, is one of the surest ways to have it neglected, with the resulting poor service. In this issue is an article, "Treatment of Direct-Current Motors for Mining Conditions," by T. H. Arnold, in which he says, "When a man has to climb a hundred or two feet of ladder, he may make the inspection by proxy." This statement is also true wherever a motor and controller are installed in a place that is difficult to get at.

The treatment for motors in mines recommended in Mr. Arnold's article can be applied advantageously to these machines in any industry where they are subjected to moisture, metallic dust, etc. It is not as generally appreciated as it should be that no matter how rigid the construction of a motor may be or how thoroughly it may be insulated, there is always a certain movement of the coils due to the magnetic forces set up about the conductors by the current. This movement will eventually crack the insulation and allow the penetration of moisture, dust, etc., which will cause breakdowns. These failures can, as has been proved by numerous experiences, be practically eliminated by a periodic cleaning and baking of the current-carrying parts and then impregnating them in an insulating compound. Such treatment must necessarily be given in the shop, which means in most cases that spare parts

or motors must be available, unless there are regular periods when the plant is down for making changes. The cost of such parts, when looked at from the price only, is not infrequently a stumbling block in the way of securing them, but when the increase in production that will result in a continuous service from the motors is considered, the investment in spare parts will generally take another aspect, and it will be seen that they will pay a substantial dividend on the investment.

An important chord in the maintenance of equipment has been struck by Mr. Arnold in his statement that "It is a psychological fact that the average man will pay more attention to keeping a nicely finished piece of apparatus in good condition than one that looks externally as though it was ready for the scrap heap"; and since the author has found that a motor can be kept in good condition around a mine, it evidently can be accomplished under almost any condition. The idea that a motor should be allowed to run until failure occurs without any attempt to anticipate and avoid trouble, is fast passing into the realm of wrong ideas, and a new order is gradually being introduced; namely, that by proper application, installation, inspection and maintenance electric-motor equipment can be made as reliable as power-generating equipment. Mr. Arnold has given one of the ways of doing this.

Ash Disposal from City Plants

THE problem of ash disposal is becoming one of considerable importance at power plants in many cities. This is due to several factors. The increase in the ash content of coal in recent years has been quite noticeable and may be greater in the future as leaner seams are worked. The increase in the size of plants and of power loads in many cases causes the production of more ash than can be used in local undertakings. There are few available dumps adjacent to most of the large power plants. Finally, there is the direct loss of combustible in the form of coke and fine coal particles. In some cases this loss has run as high as fifty per cent of the total ash, although fifteen per cent is considered good practice in the best plants.

If too much emphasis is placed on low carbon in the ash there is danger of the fireman admitting too much air into the furnace in an endeavor to reduce the percentage of wasted coke. Several attempts have been made to treat the ash in a modified washer, and while this is said to be practically possible, it was not an economic success because the cost of the process and the high water content of the recovered material offset any saving effected.

Where waste land is available, especially if adjacent to the plant, ash can be used as fill. In New York City most of the ashes are loaded on barges, hauled to sea and dumped. Unless these are taken to deep water some portions wash up on shore to the detriment of the beaches. In cities like Chicago, where there are neither low mud flats nor deep sea for dumping, the problem is quite a serious one. For a while railroads used all surplus ash for embankments, fills, etc., but in some cases they are now unable to handle the large amount available, owing partly to car shortage and partly to the temporary stoppage of railroad extensions. Several companies and even some of the smaller business concerns are finding the disposal of ash an expensive burden.

Engineers of this country must find some economical means of disposing of this waste material. In several stations in England the ashes are screened and graded and used for concrete and various other forms of construction. Possibly a similar use might be found here. Cinder concrete is highly resistant to fire, is lighter than ordinary concrete, and hence forms a desirable material for building construction. If ash can be properly sized and screened, there may be a field for it in this use as well as for sidewalks, road bases, etc.

The costs of this preparation are not known. However, there should be some means of utilizing this waste material as a byproduct of the plant by finding an industrial use for it. There may be other ways than those indicated in the foregoing that some engineers have found satisfactory. If we are to avoid huge ash piles resembling culm banks around our power plants in certain cities, some use must be found for the ashes, and this must be done quickly.

The Semi-Diesel Engine Association

IN GENERAL contradiction to the policies followed by European manufacturers of oil engines, the American builders have heretofore maintained a marked disinclination to make public any information as to experiments conducted or difficulties encountered and overcome. This attitude, while it allows each manufacturer to be the sole beneficiary of his experimental work, is actually antagonistic toward the popularizing of the oil engine. No other influence has had such weight in the discouraging of sales as this too prevalent factor of secretiveness.

The manufacturers of semi-Diesel engines are to be congratulated that they have abandoned this attitude and have organized an association to promote the popularity of the semi-Diesel engine. To accomplish this, two courses of action will be followed. A freer interchange of information on design and manufacture will be put into effect. Furthermore, the association intends to give a considerable amount of publicity to their product. To attain the latter feature, the association will find that more results can be secured by closer co-operation with the magazines that cover the field of internal-combustion engineering. *Power's* columns are open at all times to a free discussion of all forms of oil engines.

Apprehending that the Northwest may suffer again this winter from a coal famine, J. F. McGee, former State Fuel Administrator for Minnesota, has addressed a letter to President Wilson, asking that the wartime control of coal be restored and prices fixed by the Government. The communication is said to contain some serious charges of profiteering and diversion of shipments. No one is particularly anxious to see the United States Fuel Administration revived and least of all the coal men, but if such a step becomes necessary, the responsibility will be theirs.

The United States Shipping Board, acting through the Department of Justice, has instituted suit against a coal contractor for alleged failure to conform to contract. Perhaps we shall find out why the Shipping Board was compelled to pay eighteen and twenty dollars a ton for coal which the dealers claim that they were selling for export for $7.29.

CORRESPONDENCE

Does a License Law Help?

The discussion that has been going on in the correspondence columns of *Power* for some time in regard to engineers' licenses seems to be one-sided and not getting anyone anywhere. I am not opposed to the license laws, either local, state or Federal, but I fail to see where they are going to help the operating engineer in the least, either by an increase in pay or by enlarging his knowledge of the proper operation of a steam plant.

We have here in the South a vast number of engineers who carry licenses of many different forms and varieties, from the United States marine license of unlimited horsepower down the line to that of some small Northern city that happens to have a local license law on its statute books. This does not necessarily mean that the present holders of these licenses are the original applicants; in fact, I heard that one of the present holders had boasted that he had stolen a license from an engine room in Chicago and was working under the original owner's name.

I know an engineer in Alabama who could not pass a written examination for the reason that he could not add a column of figures or multiply two times two and get the correct result; yet this man's 2,500-hp. cross-compound engine and the 2,000-kva. turbine cannot be beaten for maintenance, operation and efficiency anywhere in the country. I further know that his employer would not let him go, license or no license.

I could cite many instances in which I have been called in to do repair work where the licensed engineer has been at fault, also where the unlicensed man has been to blame, but of the two cases the licensed engineer has been the most to be criticized, as the most was to be expected of him, for he was supposed to have passed an examination and proved his ability.

Where, may I ask, would a license help in the case cited by R. G. Summers in the Sept. 14 issue? If the operator of that particular plant had all the licenses that were ever issued they would not have prevented the overloading nor have shortened the period of ten months' cleaning, as those are things strictly up to the operator himself. If he were the man he ought to be to operate a steam plant, he should have been able to show his employer where he was wasting money by overloading the boiler to the amount stated.

If the engineers of the country want a license law why don't they get it? The engineers of Massachusetts got one back in 1895, and got it through their own untiring efforts. I consider it a pretty good law at that, yet it is not all that a license law should be, by any means.

The holder of a license may be no better as an engineer than one who does not hold one, and the license does not make a man any more capable of approaching his employer with a suggestion than if he did not have one. I do not believe that an employer thinks any more of a man with a license than he does of one without. The only thing that a license might do would be to certify that the holder was a competent man to operate a plant, in the eyes of the examining board, and that could be very easily found out as soon as the man began work, if his employer knew anything at all.

I cannot see that the engineers of the country would be any better off with a license law than they are at the present time. Of course, if it is necessary to pass a law to make an engineer study and fit himself for a license, why all right, but I would call it a compulsory-education law rather than a license law.

In conclusion I will say that I hold a Massachusetts first-class license and have had it for nearly 25 years.

Gordon, Ga. CHARLES N. SHAW.

Another Veteran Engine

I have a 14 x 36-in. Putnam engine that has an honorable record. It was installed in 1894 and for nineteen years the repair bill on it was less than five dollars.

The cylinder was then rebored, and new packing rings were added to the piston. A new governor was put on and the speed increased from 75 to 100 r.p.m. The piston rod was in almost its original condition, the variation in size being only 0.01 in. A cut of $\frac{1}{64}$-in. was taken to make it true.

This engine has been in service for 26 years and has always been packed with one kind of fibrous packing. But one brand of cylinder oil has ever been used to lubricate the valves and piston. The main and outboard bearings, also the crankpin boxes, have never been repaired and are in excellent condition now.

New Haven, Conn. W. H. WAKEMAN.

Commutator Made from Copper Block

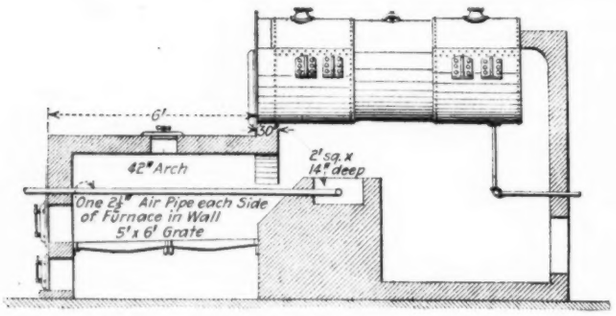
Referring to *Power* of Sept. 21, page 458, the article by Vernon Pearson on "Commutator Made From Copper Block," I wish to inform you that this method has been used for several years. A patent was taken out in August, 1916, by Edward F. Smith, of Cincinnati, Ohio. This patent (No. 1,195,861) was assigned to the Neil & Smith Electric Tool Co., and is still in force. Anyone using this method is liable for damages. H. E. WEIGHTMAN.

Chicago, Ill.

Had Trouble Burning Hog Fuel

When I came to my present plant, they were cutting out oil burning and putting in wood-burning furnaces, which were a miserable failure. We used slab wood direct from the mills. After about six months of this, a change to hog fuel was made, using furnaces designed as shown. These furnaces started off as though they would amount to little more than when slab wood was used, but study, good firemen and hard work have enabled us to get sufficient steam with but four of the six boilers in use.

The principal trouble with this hog fuel is that it is



DESIGN OF FURNACE FOR BURNING HOG FUEL

anything from large-sized slivers to all sawdust of the finest sort; our ashpits at first had to be cleaned twice a day, and the expense of handling so much charred fuel was a chronic complaint. We tried changing to another design of grate, but obtained no better results. The grates would clog so badly that we had to clean them during a day's run and the screens on top of the stacks would so fill with soot as practically to stop the draft, which nearly put out the fires and covered the town with particles of burnt fuel as well.

This condition was overcome by the use of a long pipe poker flanged at one end and used to tamp the fuel tight so as to close all holes in the pile, thus compelling the air supply to come in from the front of the pile. If a fireman allows the fuel to get too low or if it is not properly tamped, the stack screens will soot up; the same condition prevails if the ashpits get too dry and hot.

I do not understand the clinkers. On some days there will be none to speak of, and the next day with the same treatment and conditions, as far as I can see, there will be nearly a wheelbarrow load from each furnace. These clinkers are not all thin and porous, but some of them are from one to nearly four inches in thickness.

Kent, Wash. C. W. FIELDS.

Repair of Semi-Diesel Fuel Pump

In a Texas power plant there are two 85-hp. oil engines. Texas crude oil is used. This oil carries a fairly high amount of sulphur. The fuel-pump plungers became roughened by the sulphur eating the surface. The rough part of the plunger destroyed the pump packing so that it was almost impossible to keep the packing oiltight. If the gland was tightened enough to stop the oil drip, the packing wedged against the rough pump plunger, preventing the pump spring from forcing the plunger back on the suction stroke.

To remedy this the operator turned up a plunger from a bronze piston rod out of an old steam pump. The eccentric rod did not strike the plunger, but a steel cap which was easily fitted to the bronze rod. Irregularity in the action of an engine fuel pump is often the result of a corroded plunger.

New York City. E. E. SNOW.

Transformer Would Not Parallel

Recently I was called upon, as trouble shooter, to determine the reason why two banks of transformers, one of three 75-kva. units and the other of three 200-kva. units, would not operate in parallel, although designed to do so. They were connected in closed delta, as in Fig. 2, and were supplied with current at 25,000-volts three-phase, stepping this down to 2,300. The transformers in one bank were of a different manufacture from those in the other, but had been built to the same specifications. Therefore, the operating characteristics would be the same, and, it could not be understood why, when an attempt was made to parallel the two banks, the switches would trip and the fuses on the primary side blow.

Either bank would operate perfectly by itself, and the voltage of the two banks was exactly the same. I checked over the wiring and found the connections were correct, therefore immediately suspected that it was a question of reversed polarity. I reversed the two secondary leads on one 75-kva. transformer and connected directly onto the terminals of the corresponding 200-kva. unit, as in Fig. 1, protecting the windings with a two-ampere fuse wire, after which the primary switch

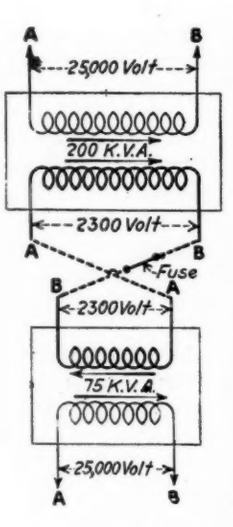


FIG. 1. TESTING TRANSFORMER'S POLARITY

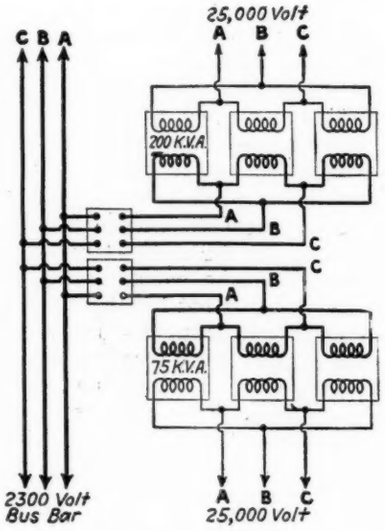


FIG. 2. CONNECTIONS OF TWO TRANSFORMER BANKS FOR PARALLEL OPERATION

was closed, and as the fuse did not blow it showed my diagnosis was correct. It was then only a matter of reversing the secondary leads on the inside of the case of the 75-kva. transformers. Upon paralleling the two banks after the leads were reversed, they went together perfectly and have operated that way ever since. The difficulty was due to one manufacturer having used the positive polarity scheme of connections and the other the negative.

Pittsburgh, Pa. M. A. ANDERSON.

Smoke-Observation Sight Hole

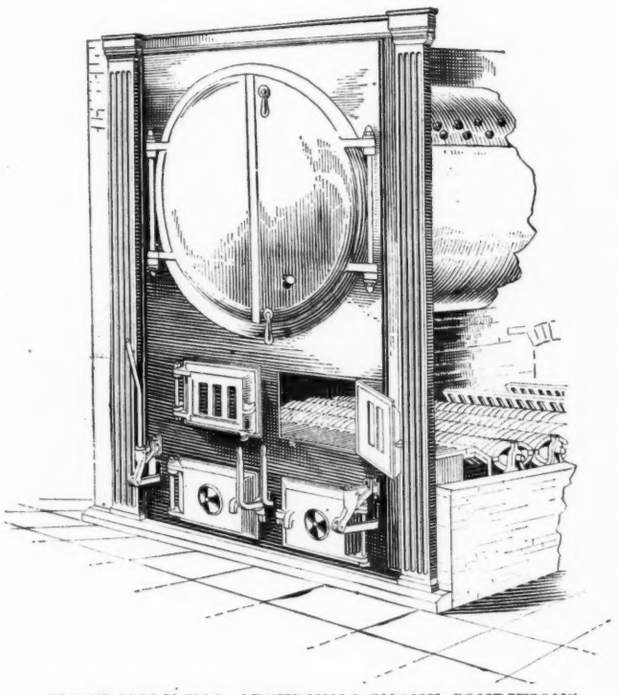
Referring to *Power*, Aug. 24, 1920, page 290, "How a Smoke Cloud Forms," by Osborn Monnett, darkness, both physical and mental, seems to hover over Salt Lake City, far too dense for penetration by those who are supposed to aid in clearing the atmospheric conditions in the beclouded city.

Primarily, the foundation for smoke clouds is laid in the installation of unscientific coal-burning devices. Firemen cannot be taught to do the impossible, hence they fail to prevent the nuisance, but by following standard methods (periscopes) may improve it some.

As an aid to the firemen through daylight or darkness, without or within the boiler room, I call to your attention the accompanying illustration designed by me, with the little sight hole in the uptake door which enables the fireman to know all about the smoke conditions at the top of the chimney.

If the furnace is properly fired, immediately thereafter the view through the boiler tube will be clear and unobstructed by smoke and the wall behind the boiler will be plainly visible. If there is smoke, the fireman will know that his furnace conditions are not right, and by the aid of the sliding dampers in the firing doors he will correct them so that the product of combustion will be CO_2.

In a few hours after taking charge of such a furnace, the fireman will learn that just enough air over



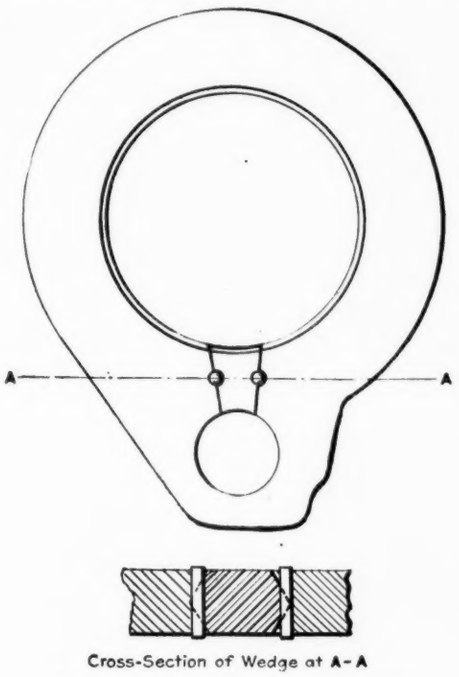
SIGHT HOLE FOR OBSERVING SMOKE CONDITIONS

the fire to burn the hydrogen gas is needed, and no more, and will adapt himself and the furnace to work together whether he fires light or heavy, and he will close the feed-door dampers when the hydrogen is consumed. His instructor is the visible condition as revealed through the sight hole, and it is unerring and unmistakable. Of course it is assumed that a proper depth of fuel is carried upon the grate and that the chimney draft is approximately correct.

Buffalo, N. Y. T. E. MARTIN.

Diesel Cylinder-Head Repair

The welding of fractured Diesel cylinder heads is not an unqualified success. It requires an experienced welder, and if extreme care is not exercised the weld will show fractures on cooling. To claim that 50 per cent of the repairs fail to hold is not overstating the



DIESEL CYLINDER-HEAD REPAIR

case. Especially is this true when applied to the head of the type A Busch-Sulzer engine, which, owing to its shape around the exhaust opening, always shows a fracture. In most cases the initial crack does no damage, but in the course of two or three years of operation at least one head on the engine must be welded or repaired. The welding distorts the lower surface of the exhaust bridge, and no amount of grinding will keep it in line with the rest of the flange surface.

Instead of welding, on one particular job a machine process was undertaken. A portion of the metal along the fracture was removed by a shaper and the edges made wedge-shape as shown in the illustration. The surfaces were hand-scraped as was also the steel wedge which was to be inserted in the cavity. The wedge had a 1 to 24 slope and was sledged into place. Two dowel holes were then drilled and pins inserted. The two ends of the wedge were cut off to conform with the adjoining surface. At one end the exhaust valve seats on the wedge, and although the latter was steel, no leaking occurred at the seat.

It will be noticed that the inner, or wide, end of the wedge rests against the male portion of the joint when the head is placed on the cylinder. Even if the dowel pins failed to hold, the male joint would prevent any movement of the wedge. The angular shape of the sides of the wedge effectively prevent any vertical motion. In operation the wedge is absolutely tight and shows no signs of fracture. The stress that exists in a welded bridge is not present. The head is, in fact, better than a new one. The cost of repairing this totaled $48, which is about one-half the cost of welding. E. E. LONG.

New York City.

Multipliers for Use with Portable Voltmeters and Wattmeters

The article on "Multipliers for Use With Portable Voltmeters and Wattmeters," in *Power* of Sept. 7, 1920, neglects one very important detail regarding wattmeter connections. Multipliers should be connected to wattmeters in such a manner that the electrostatic stresses between the potential and current coils of the instrument do not exceed those for which the instrument is designed. Where the current coils of the wattmeter must carry the line current, the multiplier should be connected between the meter and the opposite side of the line from that which goes through the series coils of the instrument. This keeps the potential difference between coils within the range for which the instrument was designed, and the connection is shown in Fig. 1.

If the wattmeter is connected as in Fig. 2, the potential between the coils of the wattmeter is equal

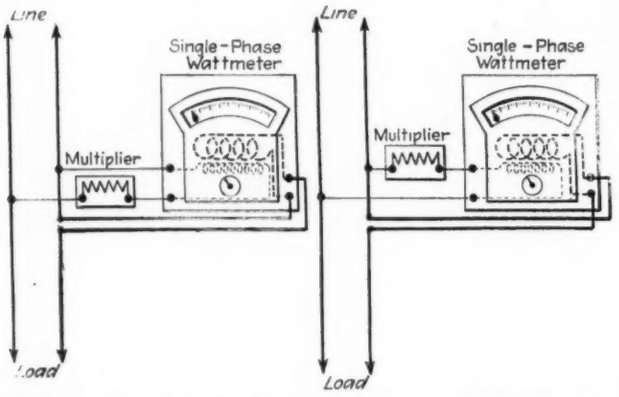


FIG. 1. WATTMETER CORRECTLY CONNECTED

FIG. 2. WATTMETER INCORRECTLY CONNECTED

to that across the line itself. This will result in distorted readings, and in probable damage to the meter if it is used on a relatively high voltage, as for instance, 2,000 volts.

It is a matter of common experience that wattmeters often burn out under apparently unexplainable circumstances. This usually happens where the meter is at first connected up with due care for the relative potentials as marked on the terminals, and, if the meter gives a negative reading, the operator interchanges the potential wires. On meters having an internal multiplier an effect similar to that given for Fig. 2 is produced. Crossing the potential leads is something of a temptation where the current leads may happen to be heavy and clumsy. Persons using wattmeters have to be careful in connecting the instrument as indicated by the manufacturers, especially as regards the relative polarity of wires.

Eddyville, Iowa. HENRY H. BRUNNER.

The article by H. C. Yeaton on "Multipliers for Use with Portable Voltmeters and Wattmeters," in the Sept. 7 issue, is both interesting and instructive, but a little stress should be laid on the limitations of the formulas and methods described, since under certain conditions their use would give exceedingly misleading results. No doubt the use of multipliers is satisfactory for practically all direct-current potential circuits, but on alternating-current meters the methods described may be used only when the potential circuit is ohmic resistance alone and the inductance is negligible; for instance, in the dynamometer-type voltmeter and wattmeter.

When there is appreciable inductance, as, for instance, in the induction-type or the moving-iron-vane type, the current in the potential coil is no longer dependent on ohmic resistance alone, but on the impedance of the circuit; consequently, instead of figuring out a multiplier with resistance equal to the ohmic resistance of the meter, say for a 2 to 1 multiplier, we must figure out one whose ohmic resistance is equal to the ohms impedance of the meter.

Take a Westinghouse portable induction-type voltmeter, for instance, with 150 volts full scale range. The total ohmic resistance is 1,210 ohms, while a milliammeter in series shows that the meter is taking only 106 milliamperes, so that the impedance is 1,415 ohms, and a multiplier must have this value to give a correct 2 to 1 ratio. Even if the frequency is changed from 25 to 60 cycles and the meter reads correctly on both frequencies, the same multiplier cannot be used on both as the impedance varies with the frequency.

If the inductance, in henrys, of the potential circuit be known, then the calculation of multipliers becomes similar to the method described, but for the value of R the following quantity for impedance must be substituted:

$$Impedance = \sqrt{R^2 + (2\pi NL)^2}$$

in which R = ohmic resistance, $\pi = 3.1416$, N = frequency in cycles per second and L = inductance in henrys.

In the case of induction-type wattmeters and watthour meters the use of multipliers is absolutely taboo, since the multiplier creates a large phase-displacement angle, making any readings almost impossible of calculation even in case of extreme necessity. Induction-type meters have been supplied with resistor-reactor multipliers in rare cases, which not only function as a multiplier, but also give the correct phase and approximately correct indication. However, their use is neither practical nor necessary as small portable potential transformers are just as convenient and can be used interchangeably on a number of different instruments and any commercial frequency whenever it is found desirable.

Another case causing much confusion is the attempt to use a multiplier on single-phase power-factor meters or single-phase synchronoscopes. In this case, as before, a multiplier will change the phase relations in the meter so that its indications are worthless and cannot be even approximated. The transformer is also the solution of this problem. E. A. REINMANN.

East Orange, N. J.

Formerly attorney for the Kansas United Mine Workers, Jake (J. I.) Sheppard, of Fort Scott, is in full sympathy with them. "The fact is," says Sheppard, "the miners have been averaging this summer only two days a week in the Kansas fields." "Why then," asked an impertinent questioner, "if that is the case, did they refuse to work on Saturdays?" Sheppard had some sort of an answer ready: "Isn't a man who works as hard as the miners entitled to some sort of a holiday?"—*Coal Age.*

INQUIRIES OF GENERAL INTEREST

Slip of Link—In operation of a link-motion reversing valve gear, what is meant by the slip of the link? L. B.

In operation the link and link block vibrate around different centers. Consequently, for each revolution of the crank of the engine the link slips back and forth a certain distance on its block, and this slippage of one on the other is called the slip of the link.

Cracked Parts of "Dry Type" Semi-Diesel Engine—What would be the cause of cracked bridges of the air and exhaust ports and piston of a "dry type" semi-Diesel oil engine? M. G.

Cracking of the parts mentioned could be caused by excessively high exhaust temperatures as a result of lime scaling of the water jacket, or a leaking atomizer, or from overloading the engine.

Submergence for Air Lift—What should be the amount of submergence of air pipe for an air lift of a well 275 ft. deep, having water 22 ft. from the surface? W. G. S.

Most efficient operation of air lifts usually is obtained with an air-pipe submergence (when the pump is in operation) that will be about 60 per cent of the total air lift, measured from the foot of the air pipe to the level at which the water is discharged, which is equivalent to a submergence 1¼ times the height of the point of discharge above the working level of water in the well.

Explosions in Diesel-Engine Air Lines—In a Diesel engine the safety plugs on the injection air lines blow out repeatedly. What causes this? R. N.

It is apparent that explosions occur in the air line. These explosions can be caused in two ways. If the fuel valve spring is very weak, the explosion pressure in the cylinder will force the valve open, allowing the flame to blow through the air line, igniting any deposits of lubrication oil in the line. Also, if the injection air leaves the compressor very hot, it may ignite any lubrication oil deposited in the air pipes.

Determining Lap and Lead of D Slide Valve—How can the lap and lead of a D slide valve be determined without removing the cover of the steam chest? W. R.

Turn the engine over slowly and make marks on the valve stem against the end of the stuffing-box gland when the valve rod is farthest in and farthest out of the stuffing box. Make a mark on the valve stem midway between these two marks and turn the engine over until this middle mark is even with the end of the stuffing-box gland. The valve then will be in the middle of its travel, and the lap on either end will be the distance the valve has to be moved before it begins to uncover the port. Open the cylinder drain cocks and try what position the wheel or crosshead will be in when the valve begins to admit steam to the cylinder and for that position mark the valve rod at the end of the stuffing box. Then the distance from this mark to the mark previously made for indicating when the valve would be at mid-travel will be the lap for the corresponding end of the valve; and the lead will be the greater distance the valve rod would be moved in or out of its stuffing box by placing the crank on dead center.

Height of Closing-in Side Walls of H. R. T. Boiler Setting—At what height should the side walls of a horizontal return-tubular boiler setting be closed in against the sides of the boiler? A. T.

The furnace sides of the walls should be closed in no higher than the highest row of tubes, and for durability of the setting it is preferable to close in not higher than the center of the boiler. Any heating surface obtained of the shell above the center of the boiler receives little benefit of circulation of the heated gases and soon becomes valueless on account of deposits of soot and ashes.

Advantages of Eccentric—When and why is an eccentric used in preference to a crank? J. D.

An eccentric is, in fact, a crankpin that is so large as to envelop the shaft. For imparting a smooth reciprocating motion, the eccentric form of a crank is preferable, because the necessary bearing surface takes up less length along the shaft, the crank motion is obtained without cutting away or reducing the strength of the shaft, and may be made adjustable lengthwise on the shaft and also in angular position with respect to the main crank or other parts carried on the shaft.

Larger Safety Valve for Relieving Lower Boiler Pressure—Can the same safety valve be used if the safe working pressure of a boiler is changed from 100 to 25 lb. per sq.in.? R. H.

If the safety valve is no larger than was necessary for carrying 100 lb. pressure, then with all other conditions the same it would be too small for 25 lb. pressure. Steam at the higher pressure is denser, contains more heat per pound and would be discharged at higher velocity through a given valve aperture, and for equivalent relief of heat a larger safety valve is needed with the lower pressure.

Advantages of Compound Engines—What are the advantages of compound engines over simple engines? J. R. M.

Saturated steam cannot be expanded more than four or five times in one cylinder without so great a range of temperature that the losses from cylinder condensation overcome the advantages of using the steam expansively. If steam of high pressure and temperature is introduced into a small cylinder, and then carried at lower pressure into the main cylinder and there expanded to the desired terminal pressure, the temperature range will not be excessive in either cylinder and, at the same time, the expansive force of the steam is fully realized. In addition the hotter steam thus comes in contact with the smaller areas of the high-pressure cylinders and there is less surface for condensation. Another advantage of compounding is that a simple engine with early cutoff and large ratio between the initial and terminal pressures is subjected to great fluctuations of stresses, requiring a stronger frame and running parts and heavier flywheel, while in a compound engine there may be the same ratio of expansion with much less fluctuation of energy of expansion causing less fluctuation of energy in the cylinders; and where the cross-compound type of engine is employed, with the cranks set 90 deg. apart, the turning effort is more uniform and the engine runs more steadily than with a single-crank engine.

Making Steam Electrically in Switzerland

By E. J. CONSTAM-GULL,
Chief Engineer, S. A. Escher Wyss Engineering Works, Zurich, Switzerland

The author describes and gives performance data on electrically fired steam boilers in Switzerland. It is not likely that electricity will be used to any appreciable extent for this purpose in North America. But in Switzerland, where water power abounds and fuel is scarce and very expensive, electric heating is more and more practiced. Time may show that at some parts of the day in sections of the American Pacific Northwest, where water-power resources are tremendous, electrical heating, even for boilers, would be desirable.

THE adoption of the electrically heated steam generator has been greatly advanced by the scarcity of fuel, and more so by the exorbitant prices charged for it. Many Swiss industries are forced to spend nearly ten times the yearly amount spent for the same quantities in pre-war times. The fuel now obtainable is not only much more expensive than it used to be, but it is less suitable for firing. Some actual cases given here may prove of interest:

1. A small cotton spinning mill requires for its planing department about 2,000 kg. (4,400 lb.) of low-pressure steam per day. With the existing ordinary boiler beechwood is the fuel burned. The price of this fuel is 40 Swiss francs[1] ($7.73) per cubic meter (35.31 cu.ft.), approximately $3.50 per cord foot, delivered. This price includes cutting. The coefficient of evaporation is three; the yearly consumption is 440 cu.m. (971 cord feet), representing a total expenditure for fuel of 17,600 Swiss francs ($3,400). In addition to this must be reckoned the yearly wage of the firemen, amounting to 23,100 Swiss francs ($4,620) per year—this only for fuel for the purpose of producing the steam for the planing.

[1]According to normal rates of exchange the American gold dollar equals 5.28 francs; at present rates the dollar equals 6.21 francs.

2. A cotton spinning mill of medium size consumes for its smoothing department about 5,000 kilos (11,000 lb.) of steam per day. The boilers are fired with beechwood and other waste wood, consuming about 3.6 cu.m. (6.62 to 7.94 cords) of wood per day, or 1,090 cu.m. (2,405.9 cords) yearly, which means a yearly expenditure for fuel at the rate of 41 francs per cu.m., equal to 1,090 × 41 = 44,700 Swiss francs ($8,630) plus 6,500 francs ($1,254) for salary for the fireman; in total therefore 51,200 Swiss francs ($9,884) for working expenses only for steam used for this particular branch of the business.

3. A worsted-yarn spinning mill requires daily for the purpose of washing the wool, etc., 12,000 kg. (26,400 lb.) of steam. The existing boiler plant is operated with American and Belgian coal, French "*tout venant*" (run-of-mine), Dutch turf (peat) and firwood chips (waste). Considering a coefficient of evaporation 5½, 2.2 tons daily or 660 tons of coal yearly is consumed, amounting to a yearly expenditure of 660 × 280 = 185,000 Swiss francs ($35,714). Adding 8,400 francs ($1,621) for salary for the fireman, a total expenditure of 193,400 Swiss francs ($37,335) results, and this only for fuel and operation of the boilers for this particular branch of industry.

4. A chemical works requires for one of its branches 48,000 kg. (105,600 lb.) of steam per 24 hours working (day and night shifts). With a factor of evaporation of 6½, 7.4 tons of coal daily or about 2,000 tons yearly must be fired. At the rate of 280 francs ($55) per ton the yearly cost for the fuel is 560,000 Swiss francs ($108,108). Adding 8,200 francs ($1,583) for salaries for the firemen makes a total cost per year of 568,200 francs ($109,691) for steam production only for this particular branch of manufacture.

These few examples will sufficiently illustrate the present high cost of steam in Switzerland. These costs must now be compared with those for producing electrical energy, the price of which, however, extends over a wide range, depending on various factors. There is no standard rate stated, referring in this instance only to the various Swiss

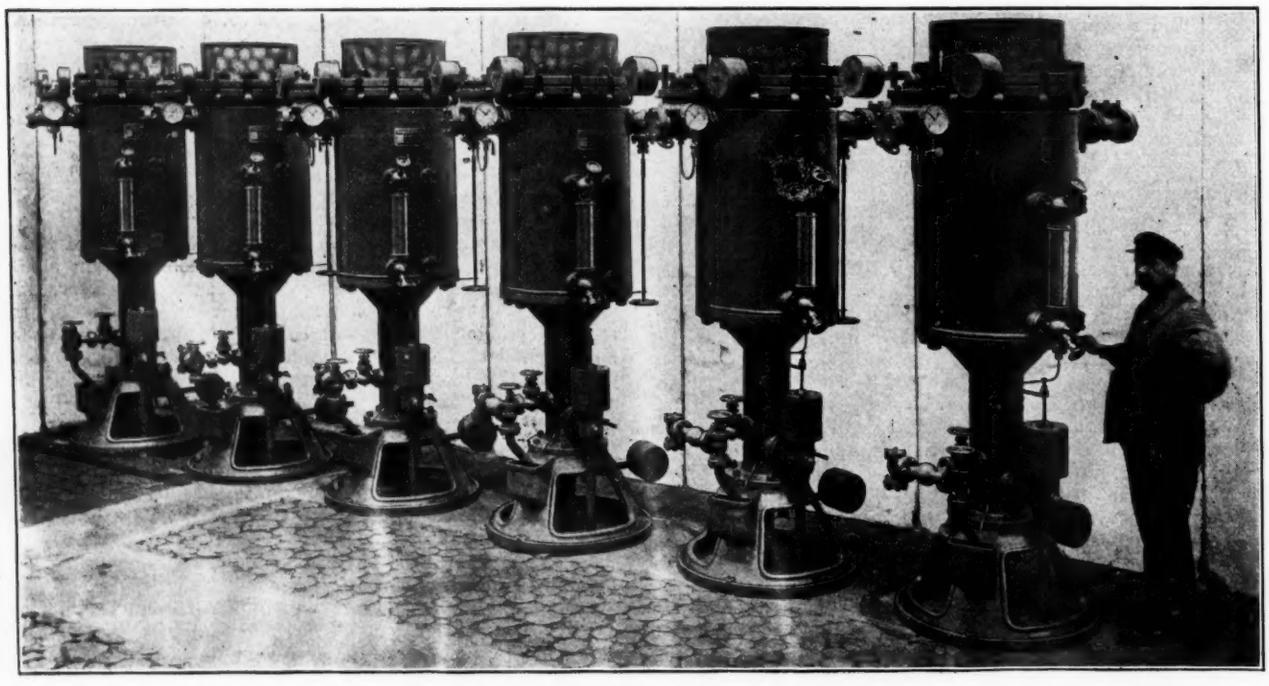


FIG. 1. A GROUP OF HEATING UNITS IN A SWISS PLANT

works that possess their own hydro-electric power plants where they obtain superfluous hydro-electric power at least during the summer season and also during the night hours. These works are no doubt in an advantageous position, but likewise buyers of electrical energy are frequently in a position by the introduction of electrical heating to reduce their working expenses to a considerable extent. It is a well-known feature of the Swiss electrical industry that, in general, there is a surplus of electrical energy during the summer months and at night compared with other times of the year and day. Considering the electrothermic economy of electrical heating apparatus, the problem of converting electrical energy into heat does not now involve particular difficulties. For instance, the electrical steam generator, Fig. 1, of the "Revel" system distinguishes itself by its compact construction, which accounts for its trifling losses of heat due to radiation. This generator has an over-all diameter of 620 mm. (24.2 in.) and a total height of 2.5 meters (approx. 8 ft.). This boiler produces 550 kg. (1,210 lb.) of steam per hour with a voltage of 500 at the terminals, and a gage pressure of 15 atmospheres (220 lb.). The same boiler produces 250 to 300 kg. (550 to 660 lb.) of steam per hour at a tension of 200 to 250 volts.

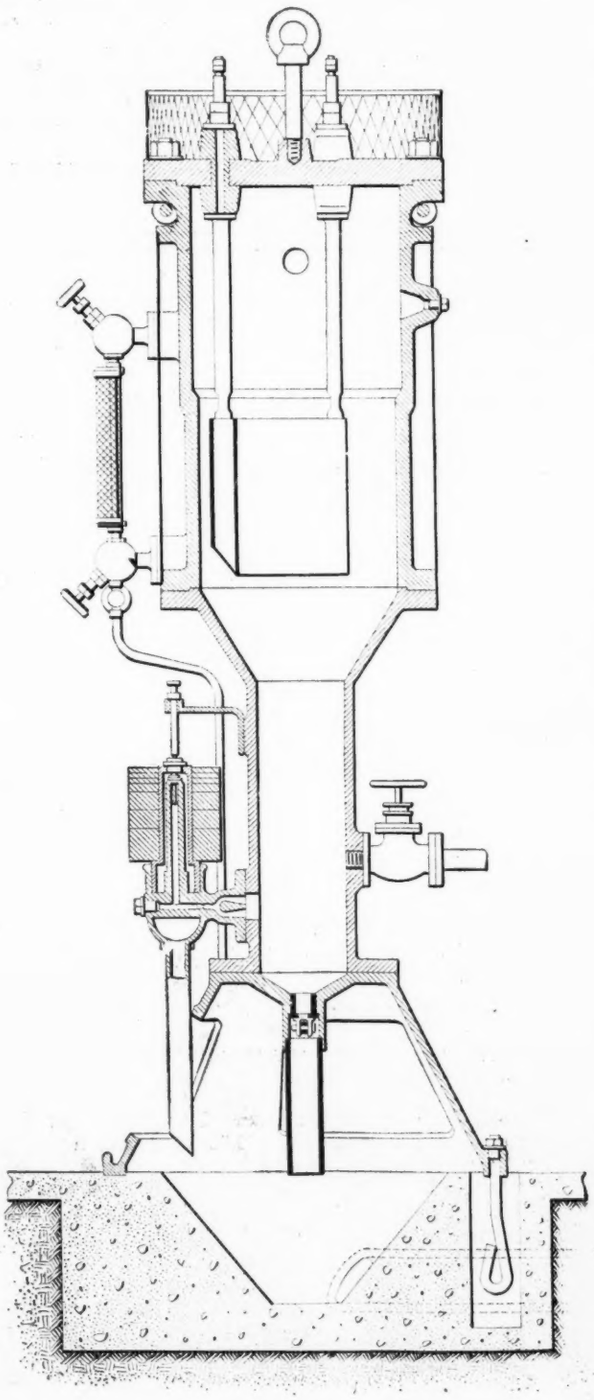


FIG. 2. SECTIONAL VIEW OF ELECTRICAL WATER HEATER

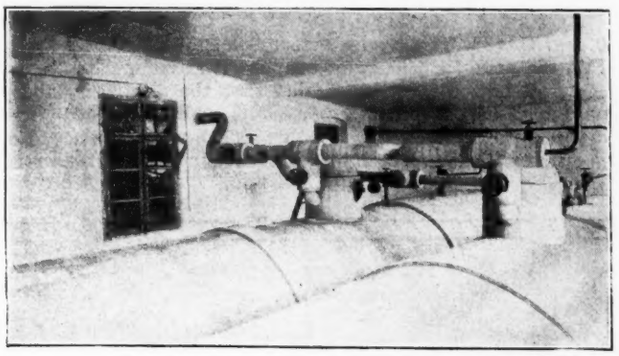


FIG. 3. VIEW OF TOP OF WATER STORAGE TANKS

Fig. 1 shows a battery of 6-hp. "Revel" boilers designed for 15 atmospheres (220 lb.). Figs. 2, 3, 4 and 5 show other views of the boiler and its application. These boilers have an external diameter of 700 mm. (27.3 in.), and a height of 2.7 meters (8 ft. ¾ in.). Their steam production per hour amounts to 800 kg. (1,760 lb.) with the voltage 3,000.

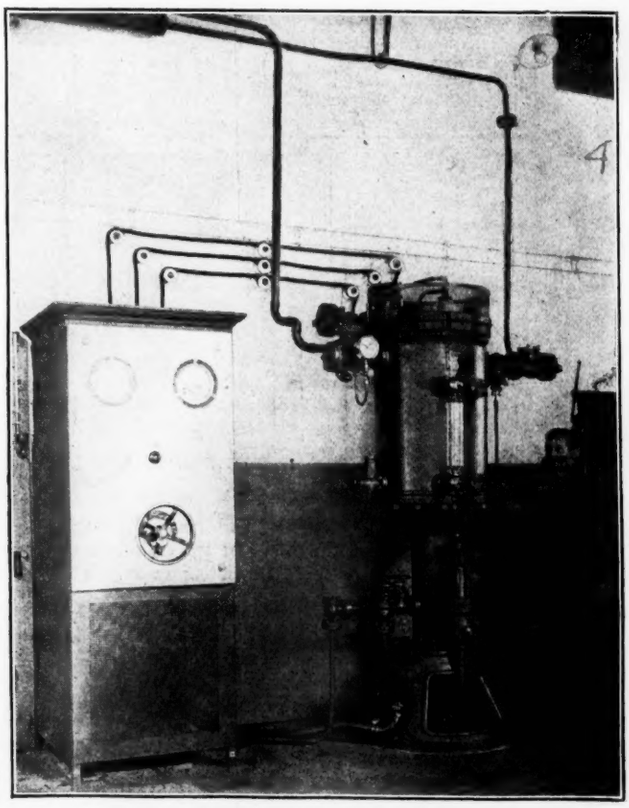


FIG. 4. RESISTANCE BOX AND HEATER

The Swiss Association of Boiler Proprietors have conducted experiments on such a Revel boiler; an extract of

the results is given here. The performance corresponds to an evaporation of 1.3 kg. (2.86 lb.) of so-called standard steam per kilowatt-hour. ("Standard steam" here means steam evaporated from and at 212 deg. F.) This steam contained but 3 per cent moisture, compared with 5 to 10 per cent for the steam produced by ordinary boilers. The evaporation and heating of steam in the "Revel" generator is accomplished at the water surface.

As 1 kw.-hr. converted 1.284 kg. (2.82 lb.) of water from 0 deg. C. (50 deg. F.) into steam of 100 deg. C. (212 deg. F.), the actual efficiency of evaporation amounts to 95 per cent. It must be borne in mind that the electrical energy used was only 146.7 kw. per hour, while the boiler was designed for a capacity of 200 kw. The variation in steam pressure was inappreciable during the period of the tests.

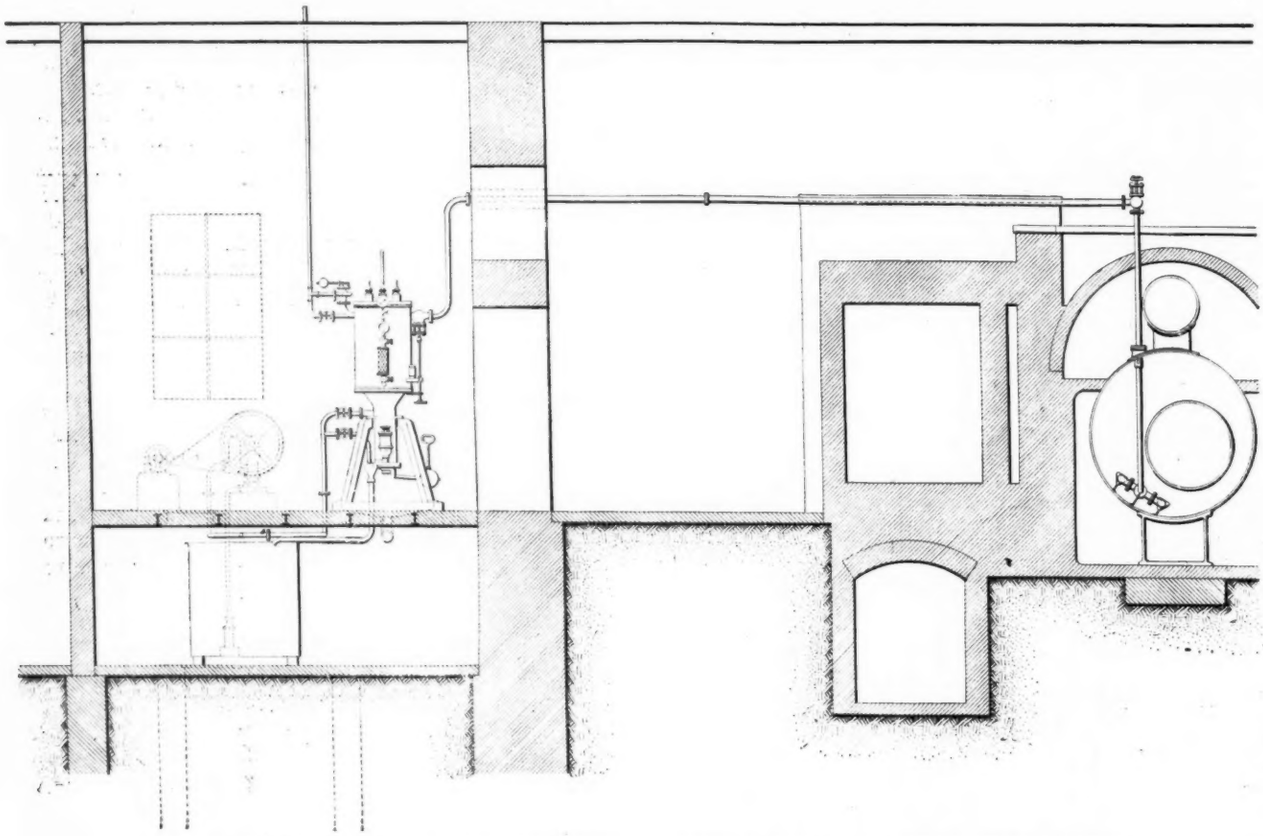


FIG. 5. SECTIONAL VIEW OF PLANT USING ELECTRICAL APPARATUS FOR STEAM MAKING

The main features of this type of boiler are the stationary electrodes which penetrate the cover of the apparatus. The intake of electrical energy into the boiler is regulated according to the quantity of steam required, and is easily arrived at by simply raising or lowering the water level in the boiler.

MAIN RESULTS OF AN EVAPORATION TEST

Electrical readings:		
Mean electrical potential (rectified)	219	volts
Ammeter readings	384	amp.
Mean electrical energy readings (rectified)	367	kilowatts
Mean electrical energy per hour	146.7	kw.-hr.
Evaporation:		
Mean steam pressure (gage) in the boiler	6.42	atm. (94.3 lb.)
Mean steam temperature of feed water, deg. C.	10	(50 F.)
Mean temperature of the waste water before check valve, deg. C	14	(57.2 F.)
Initial heat per kg. of steam	652.6	cal./kg. (2,584 B.t.u. per lb.)
Total evaporation (gross)	461	kg. (1,014 lb.)
Total evaporation per kg. (gross)	182.2	kg. (405 lb.)
Steam produced per kw.-hr. (gross)	1.256	kg. (2.76 lb.)
Water of 10 deg. C. (50 deg. F.) inlet temp. converted into steam of 100 deg. C. (212 deg. F.)	1.284	kg. per kw.-hr. (2.824 lb.
Percentage of moisture in steam	2.93	

Even a low water level in the boiler does not involve any danger, as this is actually the case with ordinary fixed boilers.

Westinghouse Company Receives Large Turbine Orders

The Westinghouse Electric and Manufacturing Co. announces that it has received within the past three months orders from electric power companies for over a half million horsepower of turbine-generators, which represents the largest volume of power business ever given to a manufacturer by private interests. These orders form one of the most effective steps that have so far been taken toward the improvement of the general economic situation. The country as a whole is short of power, and in consequence industry of every kind has been hampered.

Among the orders received by the Westinghouse Company are the following: Cheswick Power Co., Pittsburgh, Pa., one compound unit of 60,000 kw. (80,000 hp.), which will be one of the largest engines ever built; Narragansett (Rhode Island) Electric Light Co., one compound unit of 45,000 kw. (60,000 hp.); United Electric Light and Power Co., New York, two compound units of 35,000 kw. (48,000 hp.) each; Brooklyn (N. Y.) Edison Co., two single units of 25,000 kw. (33,000 hp.) each; United Electric Co., Springfield, Mass., a single unit of 25,000 kw. (33,000 hp.); Commonwealth Edison Co., Chicago, one compound unit of 35,000 kw. (48,000 hp.); Havana (Cuba) Electric Railway Co., two single units of 25,000 kw. (approximately 33,000 horsepower each.

Commenting on this large sale of steam turbines, E. H. Sniffin, manager of the power department, Westinghouse Electric and Manufacturing Co., pointed out that the business in large turbine units was about equally divided, as to number, between units of over 30,000 kw. and units of under 30,000 kw. rating.

From the present knowledge of design it appears that this will continue to be the case for some time to come, but of course definite prediction cannot be made on account of the rapid development in the industry.

Economies in Pumping-Station Operation at St. Louis*

A Review of Coal-Saving Efforts and Results in the Past Five Years—Boiler Efficiencies Increased by Changes in Grate Settings and Baffles—Pump Duties Raised by Using Superheated Steam

OWING to the rapid increase in the cost of coal it became imperative on the part of the mechanical engineers of the St. Louis Water Department to make a thorough investigation of the heat losses existing in our respective pumping plants with a view to reducing the losses to the lowest possible minimum. Coal makes up probably 40 per cent of the total pumping cost. The object of this paper is to present an account of the pumping-station economies effected at St. Louis during the last five years.

According to our experience, the chain-grate type of stoker is best suited for burning the low-grade clinkering coals, such as are found in the Illinois coal fields within a radius of 25 miles from St. Louis. This type of stoker is capable of meeting any peak load up to 100 per cent above normal boiler rating. Its first cost is about half of that of the forced-draft underfeed type. A ratio of 1 sq.ft. of grate surface to 45 sq.ft. of boiler-heating surface has given the best results, considering our loads and coals. The coal setting of the boiler. The arches are set 12 in. from the grate at the front end, rise rapidly to a hip, and are 36 in. high at the rear. The length of the arch is 6½ ft. This arch has a better concentration of heat rays near the feed gate, the rays being reflected from the bridge wall, than the one shown by Fig. 1, due to obtaining a contour which approximates the curve of a parabola, in which curve all reflected heat rays would concentrate at the focus.

Comparative tests made before and after the change in the arch shape showed: With the old type of arch, on a capacity test run by the stoker contractor, an evaporation of 15,770 lb. of steam per hour was maintained for ten hours. With the new style arch an evaporation of 17,140 lb. of steam per hour was generated for five hours. The former represents an overload of 38 per cent, while the latter represents an overload of 60 per cent. At the same time the average boiler efficiency was increased from 58 to 63 per cent, or a gain in efficiency of approximately 9 per

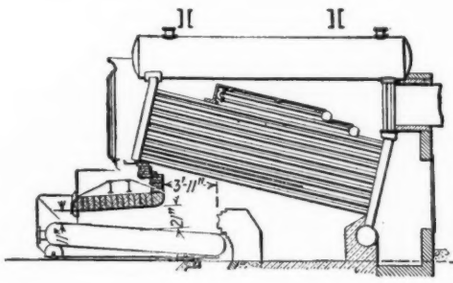


FIG. 1. OLD SETTING AT CHAIN OF ROCKS

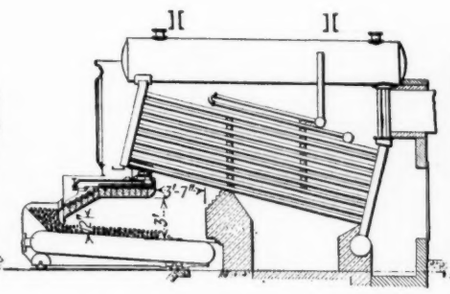


FIG. 2. NEW SETTING AT CHAIN OF ROCKS

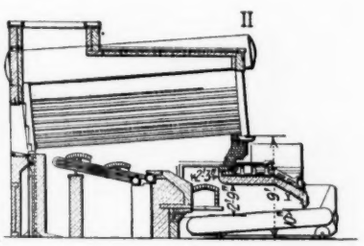


FIG. 3. NEW BOILERS AT BADEN STATION

is 2-in. Southern Illinois screenings having an average heat value of 10,300 B.t.u., with from 20 to 25 per cent ash.

The first chain-grate stokers we installed were at the Chain of Rocks plant in 1914. They were placed under six National water-tube boilers, each of 360 hp., and two O'Brien water-tube boilers, each of 250 hp. capacity. The boilers were set 7 ft. from the floor, and the arches were set 11 in. from the grate at the front and 22 in. from the grate at the rear, the arch being 6 ft. 5 in. long. The original arch was set according to the design of the stoker contractor. The boilers were arranged with horizontal baffles, the lower baffle being placed on the second row of tubes. The average boiler efficiency under operating conditions with this setting was approximately 58 per cent, and it was difficult to obtain an overload of 25 per cent.

By referring to Fig. 1, which shows the original arch, it will be apparent that from the standpoint of obtaining a large liberating volume under the arch and an efficient shape of the roof so as to obtain the maximum benefits of heat reflection coming from the bridge wall, this arch did not function properly. It did not permit a concentration of heat at a point where a maximum concentration is desired; namely, at the point of ignition. These objectionable features have been overcome by the new design of arch shown by Fig. 2.

In this setting the distance from the floor to the front water leg remains 7 ft., being determined by the original cent. After all the boilers have been equipped with the new arch, it is estimated that the saving in annual coal cost will amount to about $5,000 at this station.

A similar improvement in capacity and efficiency was made at the Bissell's Point Station. The boilers here are set with the front water leg 6½ ft. above the floor line. The original arches were sprung transversely across the grate, 9 in. above the grate at the hip, rising to 18 in. above the grate at the center. Longitudinally, the arch was parallel to the grate. This type of arch (that is, in respect to the low height above the grate) was the common practice among chain-grate stoker builders up to within but a few years past. The arch was removed and replaced with a new type of flat arch, which is 12 to 13 in. above the grate at the feed gate and rises straight, without a hip, to 30 in. above the grate at the rear end. The length is 7 ft. Because of the limitation of the low setting, it was not possible to construct a hipped arch at this station. However, a good saving was effected for the reason that, prior to the change in arch design, it was only possible to burn crushed egg or lump coal at this station, owing to the low arches, which did not effect a proper ignition with the lower grades of screenings. With the new arch the lower grades of screenings are burned successfully, and the same evaporation is obtained per pound of coal with screenings as with the crushed egg or lump coals, thereby resulting in a saving in the price of coal of about 18 per cent. When applied to our last year's coal cost at this station, this amounts to an annual saving of about $10,000. After all the boilers at this station were equipped with the new type arch, the

*Abstract of a paper by L. A. Day, Engineer-in-charge Operating Section, Water Division, St. Louis, Mo. Read before the American Water Works Association, June, 1920.

average over-all rating of the boiler room rose from 90 per cent to 115 per cent, even with the use of lower-grade coal.

The experiences outlined led us to adopt, in the installation of new boilers at the Baden plant, a setting in which is embodied a construction which we believe eliminates all objectionable features found by previous experience (Fig. 3). In this setting the arch is similar to that of the new arch for the Chain of Rocks Station, the distance at the feed gate above the grate is 10 in., rising rapidly to a hip, and is 34 in. above the grate at the rear. The length of the arch is 7 ft. The height of the front water leg above the floor is 9 ft., this height providing a larger combustion chamber than in the previous settings, thereby obtaining a more thorough mixing of the gases and oxygen and providing a relatively longer gas travel, all of which is necessary for the efficient burning of coal at high rates of combustion. The evaporation at this station averages 6¼ lb. of water per pound of coal at a boiler efficiency of 66 per cent, and comparing this performance with that of the other stations, when the old type of settings prevailed, shows a saving of about 13.8 per cent in coal.

As has been previously stated, the over-all boiler efficiency of the other two stations is 63 per cent with the improved arches, while that at the Baden station, with practically the same style arch as was adopted at the other stations, shows an over-all boiler efficiency of 66 per cent. This increase of 3 per cent in efficiency, or a gain of 4.8 per cent, may be attributed to the higher boiler setting; namely, 9 ft. instead of 7 ft. which prevails at the other two stations. In other words, by setting the boilers two feet higher at the Baden station, we show a gain of 4.8 per cent in over-all

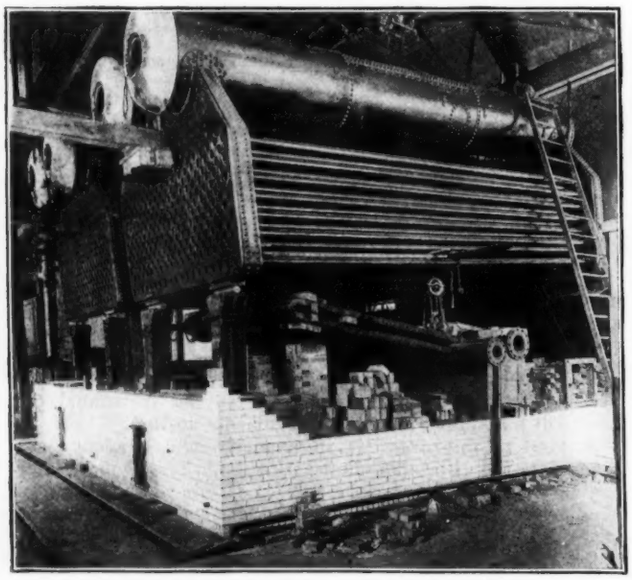


FIG. 4. VIEW OF SETTING OF BOILERS AT BADEN STATION, SHOWING SUPERHEATERS IN COMBUSTION CHAMBER

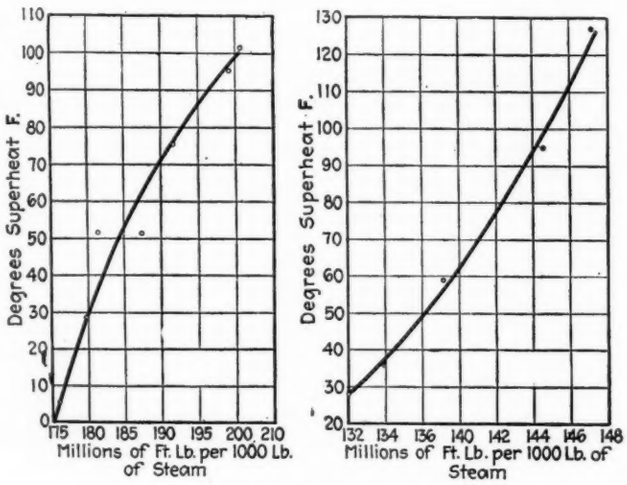
boiler efficiency, and this gain when computed on the annual cost of coal at this station, amounts to $3,000 annually.

The gains mentioned are principally due to the improvement in furnace design, but part of the saving in coal must be credited to improvements made in boiler baffling.

Boiler baffling should be so placed as to force the gases into contact with all parts of the tube bank. In the older Heine type of settings at our plants, the lower baffle was made up of box tile on the lower row of tubes, and the upper baffle was 13 tubes above on the top row of tubes. The opening in the lower baffle was in some cases as much as 60 in. from the rear water leg. The path of the gases in this type of boiler was diagonally upward through the tubes, leaving the rear water leg and the tube ends near it untouched by the hottest gases.

By eliminating the box tile on the lower row of tubes and placing a specially designed tile on the third row of tubes, and also reducing the opening in the lower baffle from 60 to 42 in., we reduced the flue temperature from an average of 650 deg. F. to 550 deg.

The use of superheated steam at all of our plants has proved to be one of the greatest factors in increasing the efficiency of the engine rooms. The Water Division has



FIGS. 5 AND 6. PUMP DUTIES OBTAINED FOR VARIOUS DEGREES OF SUPERHEAT AT ST. LOUIS

made tests on the effects of superheated steam on triple expansion and on compound pumping engines. The triple-expansion engines, which pump against 85 to 125 lb. pressure and whose capacities vary from 15 to 20 m.g.d., showed a saving for various degrees of superheat as represented by the curve, Fig. 5. The steam saving for 100 deg. superheat amounted to 12.1 per cent, while the saving in coal amounted to 7.5 per cent. The low-service compound pumping engines, which pump against a maximum head of 65 ft., or about 28 lb. pressure, and whose nominal capacity is 30 m.g.d., showed a saving for various degrees of superheat as represented by Fig 6. The steam saving for 100 deg. superheat amounted to 17.3 per cent, while the saving in coal amounted to 13.2 per cent.

The saving in coal due to the introduction of superheated steam at the Chain of Rocks station has been sufficient to pay for the superheaters in about 3½ years. The life of a superheater, when the elements are not exposed to the direct flame, should be equal to the life of the boilers.

When the compound pumping engine was originally installed 25 years ago, it developed a duty of 118,000,000 ft.-lb. per 1,000 lb. of saturated steam, no superheat being used. The pumping engines at this station were all bought on the bonus and forfeiture basis, which naturally led the contractor to make every effort toward obtaining the highest duty possible. The Water Department, however, in running the duty tests with variable degrees of superheat, made no attempt whatever to increase the economy of the pumping unit before the test was run—by increasing the vacuum, repacking the plungers, renewing pump valves, inspecting valves and pistons, etc. In other words, the test was made on a pump running under every-day plant conditions, and even with a superheat of only 28 deg., which is the lowest obtainable, the pump developed a duty of 132,000,000 ft.-lb. per pound of steam, which is a saving of 11.9 per cent in steam consumption over that of the original duty test with saturated steam, where the duty obtained was 118,000,000 ft.-lb. per 1,000 lb. of steam. This is a very creditable showing for a pump that has been in service for 25 years.

There seems to be, to the writer's knowledge, a prevailing impression in a great many water-works plants, that the use of superheated steam, with its consequent economies, is offset by difficulties with lubrication. This contention is not borne out by our experience.

Our turbine-driven pumps are installed in the same station with the low-service compound pumping engines previously referred to. Two of these are of the single-stage centrifugal type, each of a nominal daily capacity of 35,000,000 gal. They were installed in 1913 and have been in active service ever since. The test duties of these pumps at a head of 65 ft. was 100,000,000 ft.-lb. per 1,000 lb. of saturated steam. A recent test run under the same pumping conditions, but with 124 deg. of superheat instead of saturated steam, showed a duty of 115,000,000 ft.-lb. per 1,000 lb. of steam, an increase in duty of 15 per cent. The physical condition of the pump may be said to have been the same during the two tests, for the reason that the unit had just been overhauled.

On the same turbine-driven centrifugal pump comparative tests were made to determine the difference in duty, with the same superheat and vacuum, before and after the pump was overhauled, as just described. The duty before overhauling was 93,500,000 ft.-lb. per 1,000 lb. of steam and after overhauling was 106,000,000, showing a saving of 13.3 per cent, due entirely to overhauling.

It might be well to mention that the pumps at our low-service station are subject to abnormal wear due to their pumping raw river water containing a large amount of sand in suspension.

Standard Specification for Steam Hose

The American Society for Testing Materials has adopted the following standard specification for steam hose:

These specifications cover wrapped steam hose, suitable for steam-heat connections when the steam pressure does not exceed 125 lb. per sq.in.

1. Manufacture

2. The hose shall consist of: (a) An inner rubber tube; (b) cotton-duck reinforcement; (c) an outer rubber cover.

3. The rubber tube shall be smooth, uniform in quality and thickness, and free from injurious defects.

4. The reinforcement shall consist of cotton duck woven with not less than 16 nor more than 22 strands per inch of width in both warp and filler, each strand having 5 threads of long-fiber cotton. The duck shall be cut and applied on a bias of from 42 to 46 deg. with edges lapped at least 0.5 in. and with both sides well frictioned with a rubber compound suitable for the required service.

5. The rubber cover shall be uniform in quality and thickness, and free from injurious defects.

2. Physical Properties and Tests

6. Where applicable, references are made below to the Standard Methods for Testing of Cotton Rubber-Lined Hose (Serial Designation: D 15) of the American Society for Testing Materials.

7. The temperature of the testing room and samples shall be as defined in Section 19 of Standard Methods D 15.

8. A portion 18 in. long shall be cut from each length of hose, except in the case of 22- 24- or 30-in. lengths, when one length from each 200 ft. or less shall be taken for test. A portion 2½ in. long shall be cut from the test specimen and subjected to the tests specified in Section 9. The remaining portion of the test specimen shall then have the exposed ends coated with a covering of rubber cement and be subjected to the digester test as specified in Section 12, after which another 2½-in. portion shall be cut from the test specimen and subjected to the tests specified in Section 10.

9. The quality of the rubber friction binding the plies together shall be determined by suspending a 20-lb. weight from the separated end of the duck of a 1-in. test ring cut from the 2½-in. sample described in Section 8, the force being applied radially. The rate of separation of the plies shall be not greater than 1 in. per minute. The test shall extend for 10 minutes when the size of the hose permits.

10. The quality of the rubber friction after steaming shall be determined, as described in Section 9, on a 1-in. test ring cut from the sample after it has been subjected to the digester test, except that a 15-lb. weight shall be used in place of the 20-lb. weight specified in Section 9.

11. (a) The tests of tube and cover shall be conducted in accordance with Sections 18, 20, 21, 22, 23, 24 and 25 of Standard Methods D 15. (b) Test specimens shall be cut longitudinally from the hose. (c) The friction between the inner tube and cotton duck shall be the same as that between the plies. (d) The tensile strength before steaming shall be not less than 600 lb. per sq.in. (e) The tensile strength after steaming shall be not less than 450 lb. per sq.in. (f) The elongation at the breaking load for both the tube and cover shall be such that the original 2-in. gage length of the test specimens shall stretch to not less than 6 nor more than 10 in. before steaming, and to not less than 4 nor more than 8 in. after steaming.

12. The digester shall consist of a closed cylinder containing dry saturated steam at a pressure of 45 lb. sq.in. The test specimen specified in Section 8 shall be placed in the digester and shall remain there for 48 hours continuously. An examination of the specimen after being subjected to the heat of the steam should be made immediately after removal from the digester and should disclose no blistering of the inner tube or loosening of the tube from the fabric. Tests after steaming prescribed in the specifications shall be made as soon as possible after the specimen has cooled for 24 hours.

3. Sizes and Dimensions

13. (a) Steam hose shall be in accordance with the sizes and dimensions specified by the purchaser. (b) The thickness of tube shall be not less than ⅛ in.

4. Workmanship

14. The hose shall conform to the dimensions specified and shall be finished in a workmanlike manner. The tube and cover shall be free from injurious defects.

5. Marking

15. (a) Each 50-ft. length of hose shall have inlaid in rubber in three places, namely, midway between the ends and within 10 ft. of each end, a brand showing the name of the manufacturer, the month and year of manufacture, the trade name of the hose, and the legend "A. S. T. M. Specifications." Shorter lengths than 50 ft. shall have one brand similar to the above inlaid in rubber. (b) Serial numbers of rejected hose shall not be applied to any other hose during the same calendar year.

6. Inspection and Rejection

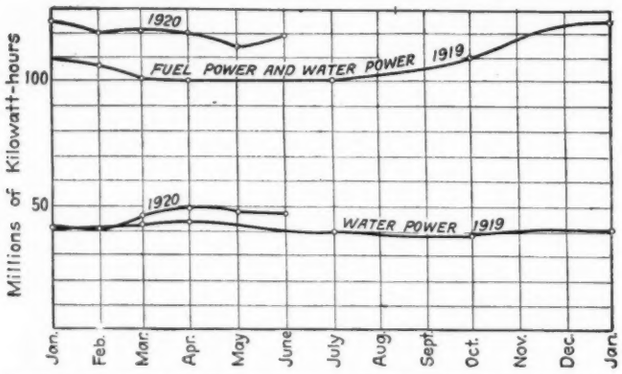
16. (a) The manufacturer shall notify the purchaser sufficiently in advance of the completion of the hose to permit of arrangement for inspection. (b) The manufacturer shall afford the inspector representing the purchaser, without charge, all reasonable facilities to satisfy him that the hose is being furnished in accordance with these specifications. All tests and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works. (c) The purchaser may make the tests to govern the acceptance or rejection of the hose in his own laboratory or elsewhere. Such tests, however, shall be made at the expense of the purchaser. 17. Samples of rejected hose shall be preserved for two weeks from the date of the test report. In case of dissatisfaction with the results of the tests the manufacturer may make claim for a rehearing within that time.

At a recent meeting of engineers from Louisville and Cincinnati in the Engineers' and Architects' Club a committee of three was appointed to investigate the feasibility of "harnessing" the falls at Louisville. Government engineers have seriously considered the project and after an investigation declared it feasible. W. H. McAlpine, U. S. Engineer, Frank H. Miller, engineer Louisville Electric Co., and Louis E. Strong, of the Louisville Gas and Electric Co., were asked to make an exhaustive investigation as to the feasibility of the falls as power development.

Production of Electricity by Public-Utility Plants

Figures given out by the United States Geological Survey indicate an annual production of electricity during 1919 by water power of 14,740,000,000 kw.-hr., equal to 37.9 per cent of the entire production of electricity; 24,160,000,000 kw.-hr., or 62.1 per cent of electricity was produced by fuel power, making an annual total of 38,900,000,000 kw-hr. The total fuel consumption during 1919 for production of electricity was as follows: Coal, 35,000,000 short tons; oil, 11,050,000 bbl.; gas, 21,700,000 M. cu.ft.

The accompanying chart, showing the average daily production of electricity by public-utility plants in the United States by water power and fuel power from January, 1919, until May, 1920, indicates that 110,000,000 kw.-hr. of electricity was produced in the early part of January. This figure dropped steadily, however, until the beginning of March, when it totalled 100,000,000 kw.-hr. Electrical production remained stationary until July, when a steady increase was noted, which reached the high figure of 134,700,000 kw.-hr. in January, 1920. During May the production had dropped to 114,600,000 kw.-hr. with a rise in June to 120,000,000.



AVERAGE DAILY PRODUCTION OF ELECTRICITY BY PUBLIC UTILITY PLANTS IN UNITED STATES BY WATER POWER AND FUEL POWER, 1919 AND 1920

A separate curve on the same chart shows the number of kilowatt-hours produced by water power. From January, 1919, until January, 1920, the production, with slight fluctuations, remained the same, showing an average of 40,000,000 kw.-hr. From February until June an increase was noted which reached its highest point in April with a total of 50,000,000 kw.-hr.

The proportion of each monthly total produced by water power beginning January, 1920, is 33, 38, 41 and 42 per cent respectively, an increase in the amount of kilowatt-hours produced by water power in May of about 27 per cent over January and February. This increase is due largely to the increase in stream flow.

The mean daily output for the first five months in 1919 was 102,680,000 kw.-hr., and the mean daily output for the corresponding period of 1920 was 119,860,000, an increase of 16.7 per cent.

In comparing the 1920 and 1919 curves of mean daily production of electricity, it should be noted that the 1919 curve from April to July is drawn as a straight line as the production for May and June, 1919, was not determined. If figures for these months were available, the 1919 curve might show the same tendency for May as the 1920 curve.

Figures indicating the number of kilowatt-hours produced by water power in various states show California by far the largest producer. Montana ranks second with less than half the production of California. In electrical power produced by fuels, however, California ranks fourth. Illinois is first, Massachusetts second and Michigan third.

It is estimated by the Geological Survey that Pennsylvania used more coal for the production of electrical power than any other state in the Union; New York second and Ohio third. Texas leads in the use of petroleum and derivatives for production of electric energy, and Oklahoma is second. In the use of natural gas for fuel by public utilities, Oklahoma is first, West Virginia is second and Ohio third.

Coal Shortage in Northwest

Important hearings behind closed doors are being held by the Interstate Commerce Commission in an effort to insure the transportation of the Northwest coal and at the same time permit a larger volume of coal to move to Midwestern destinations. All interests concerned are being given an opportunity to be heard. Despite every effort, the railroads have found it impossible to meet the Lake program. With the advent of cool weather the Midwestern States have refused to wait longer for their coal.

A minimum of two thousand additional cars would be required daily if anything like the general distribution of coal is to be secured in Ohio, Indiana, Illinois, and Michigan. The railroads are positive that they cannot take care of this additional movement under present conditions. The commission has given no intimation as to what measures it will take. It may restrict the use of open-top cars to coal movement until the close of navigation. Color was given in this solution by the fact that the commission has called on representatives of the steel and sand and gravel industries, the largest shippers of open-top cars. Another possibility is that the priorities being enjoyed by public utilities may be suspended.

New Publications

GAS AND FUEL ANALYSIS. By Alfred H. White, Professor Chemical Engineering, University of Michigan. Published by McGraw-Hill Book Co., Inc., New York City. 290 pages; 57 illustrations. Price, $3.

A number of volumes dealing with fuel analysis have been published the past few years. Unfortunately, the majority have been of a character that failed to meet the needs of the power-plant engineer. Other volumes written especially for the operating force have been entirely too elementary. While the volume under discussion was written primarily for classroom use, it should meet a ready reception from the practical engineer. The method and apparatus required in fuel testing and gas analysis are fully covered.

ADVERTISING THE TECHNICAL PRODUCT. By Clifford Alexander Sloan and James David Mooney. Published by the McGraw-Hill Book Co., Inc., 239 W. 39th St., New York City. Cloth. 6 x 9 in.; 365 pages.

In this book the more important factors of the advertising problem that are peculiar to advertising the technical product are discussed. The work was compiled with the assistanc and co-operation of a number of business men. The efforts of these men, who have all been successful in various phases of the work discussed in the book, have resulted in impregnating it with the substance of practical experience. The book is made up of five parts: The general problem and its economic elements; the instruments available for advertising the technical product; technical advertisements; advertising organizations; and appendix.

FUEL OIL IN INDUSTRY. By S. O. Andros. Published by Shaw Publishing Co., Chicago, Ill. 240 pages; 107 illustrations.

The author of this volume has endeavored to cover the use of oil as fuel in the various industries. The work as a whole is quite good; the first chapters, dealing with the physical and chemical characteristics of oil, are especially worthy of comment. Suitable space has been given over to a discussion of colloidal fuel. A number of chapters are devoted to oil storage, heating, pumping and similar questions concerning the handling of oil. In the remainder of the volume the author has given entirely too much space to descriptions of industrial processes, much of the material having but little bearing on the use of oil as fuel. More pages should have been devoted to methods of installation and proper operating procedure. To those who desire to secure a general understanding of the employment of oil as fuel in industrial processes this work will prove a welcome find.

Obituary

Augustus C. Buzby, president and founder of the Keystone Lubricating Co., of Philadelphia, died Sept. 21, at the age of sixty-six years. Mr. Buzby came of an old Quaker family, which settled in Burlington County, N. J., in 1640. He attended the Philadelphia College of Pharmacy, and after his graduation devoted himself to chemistry; later, he organized a wholesale drug-supply business. He was best known, however, as the founder and president of the Keystone Lubricating Co., which he built up into a large and successful organization. He left a wife, Florence Buzby, and four sons, in whose hands the direction of the Keystone company now rests. These men are: Harold A. Buzby, vice president and general manager; Warren F. Buzby, second vice president and treasurer; Norman F. Buzby, secretary and export manager; and Kenneth K. Buzby, assistant treasurer. Mr. Buzby was a prominent Mason, and was a member of the Manufacturers' Club of Philadelphia, the Philadelphia County, Pen and Pencil, Friendly Sons of St. Patrick, Terrapin Club and other organizations. He was also a vestryman of the Episcopal Church of the Savior. He leaves a host of friends who mourn the loss of a square-dealing and honorable man.

Personals

Herbert Hoover has been appointed a member of the advisory Board for the Eastern Industrial Region, Superpower Survey, now being conducted by the Geological Survey.

J. R. Lowe, sales engineer for the Midwest Engine Co., has been transferred from the New Orleans office of the company to the Hill Pump Works Division, at Anderson, Ind.

T. Walter McGrath, for eight years with the Electric Storage Battery Co., is now with the M. J. Dougherty Co., power piping contractors, fabricators and erectors, Philadelphia, Pa.

W. G. C. Thompson, formerly mechanical engineer, D. G. Dery, Inc., Allentown, Pa., has been appointed assistant professor of mechanical engineerng at the Pennsylvania State College, State College, Pa.

Carl C. Thomas has been appointed Western representtive of the Dwight P. Robinson & Co., Inc., engineers. Mr. Thomas will be located in the Electric Equipment Buiidlng, South Hope St., Los Angeles, Cal.

Paul J. Keifer, formerly assisant professor of steam engineering, University of Illinois, is now associate professor of mechanical and marine engineering, Postgraduate Dept., U. S. Naval Academy, Annapolis, Md.

A. G. Christie, formerly associate professor of mechanical engineering, Johns Hopkins University, Baltimore, Md., has been appointed professor of mechanical engineering of the Night Technical Schools of Johns Hopkins University.

J. H. Klinck has been discharged from the army as Major, Q. M. C., Construction Service, and has returned to the Westinghouse Electric and Manufacturing Co. He will be located in the general sales department of the East Pittsburgh Works.

Francis Irman has become publicity manager of the Quigley Furnace Specialties Corp., of 26 Cortlandt St., New York City. Mr. Irman has had long experience in the advertising field and is a trained engineer, having received his engineering degree from Kings College, London, England.

H. J. Marks, formerly sales engineer and district sales manager, of New York, for the Badenhausen Co., manufacturers of boilers and American ball engines, is now established at 90 West St. as H. J. Marks & Co., Inc., Sales Engineers, and will act as New York agents for the Badenhausen Boilers, etc.

Ragnar Garlstedt arrived in America on the steamer "Imperator" Oct. 2. He was formerly connected with the Swedish General Electric Co. and is the inventor of many electrical and mechanical devices used in gas plants, pulp and paper mills and power plants. While in this country his address will be Grand Central Palace, New York City.

Society Affairs

The American Association of Engineers will meet at the Engineers' Club of Philadelphia, Oct. 13.

The American Society of Heating and Ventilating Engineers will meet on Oct. 14 at the Engineers' Club of Philadelphia. Dr. John R. Allen will read a paper on "Résumé to the Work of the Research Bureau."

The American Institute of Electrical Engineers will meet at a luncheon at the Engineers' Club of Philadelphia, Oct. 12. Dr. George K. Burgess will address the members on "Bureau of Standards and Its Engineering Contacts."

Members of the Illuminating Engineering Society will meet at a luncheon, Oct. 19, at the Engineers' Club of Philadelphia. "The Inspiring Outlook for American Engineering" will be the subject of an address by Morris L. Cook.

The Detroit Engineering Society will hold its regular meeting Oct. 15. Frank J. Raymond, of the Inter-Racial Council, New York City, will read a paper on "The Relationship of Foreign Labor to Its Employees."

The Detroit Engineering Society will meet on Nov. 5. E. J. Mehren, editor of *Engineering News-Record,* who has just returned from an extensive trip through Europe, will read a paper entitled "Conditions in Europe from a Political, Social and Engineering Standpoint." On Nov. 19 another meeting will be held at which Major Theodore A. Leisen will read a paper on "The New Water Filtration Plant for Detroit."

The National Association of Practical Refrigerating Engineers will hold its eleventh annual convention at the Auditorium Hotel, in Chicago on Dec. 8 and 11, 1920. This is the first meeting of this association to be held in Chicago, and the arrangements that are being made for it indicate that it will be one of the largest ever held by the association. The program has been selected because of its importance as relating to modern, practical refrigeration engineering.

The Glasgow Corporation is making preparations for the engineering, shipbuilding and electrical exhibition that is to be held in the Kelvin Hall, Glasgow, from Nov. 8 to Dec. 4. This hall has an area of over 200,000 sq.ft., and is well adapted for such an exhibition, and will contain, when the show is open, three miles of passageway with stands on both sides. A cinematograph hall is being planned in connection with the exhibition to show films devoted to the engineering, shipbuilding and electrical industries. The exhibitors are to include most of the well-known British engineering firms. It is reported that over 15,000 personal invitations have been dispatched to foreign visitors, for whose benefit, during their stay in Glasgow, advisory bureaus are to be set up by the corporation at the principal Glasgow stations.

Business Items

The Wasioto (Ky.) Light and Power Co. was organized by E. M. Bell and others with a capital of $30,000 for the purpose of installing a plant. The work will be launched at once.

The Hart Co., of Williamsport, Pa., announces its incorporation, under the laws of the State of Pennsylvania with a capital of $100,000. The concern will manufacture a complete line of valves, faucets, basin cocks, etc. The incorporators are Walter Hart, Harry A. Miller, LeRoy W. Gleason, Edgar R. Munson and Harry S. Kolb, all of Williamsport.

Trade Catalogs

The McAlear Manufacturing Co., manufacturers of specialties for steam heating and power plants, have ready for distribution two booklets, "A" and "B," entitled respectively, "Vacuum System of Heating" and "Vapor Heat." The booklets contain illustrations and text illustrative of vacuum and vapor heating specialties. Copies will be sent on request.

The A. & F. Brown Co., engineers, founders and machinists, of New York City, have ready for distribution a new 130-page catalog entitled "Power Transmission Machinery." The catalog contains numerous photographs and line drawings descriptive of the text. The volume includes descriptions of glass, shafting, couplings, bushings, pulleys, and various other apparatus pertaining to power transmission. A copy will be sent on request.

The Link Belt Co., of Chicago, has ready for distribution a revised edition of catalog No. 380. The booklet which contains 96 pages covers the Link Belt line of standardized monorail electric hoists as well as overhead traveling cranes in capacities of ½ to 3 tons. It completely describes these machines, giving tables of weights, clearance dimensions and speeds, and contains illustrations. Copies can be had by applying to the Link Belt Co., 910 So. Michigan Ave., Chicago.

"Reciprocating Engines and Steam Turbines" is the title of a new 135-page booklet just issued by the Travelers Indemnity Co., Hartford, Conn. Principles of safe and economical operation of reciprocating and steam turbines is the subjected treated in the booklet. The first main division deals chiefly with plant conditions, accident causes, safeguards, etc. The second division takes up the discussion of certain theoretical points that should be of interest to the thoughtful engineer. Particular attention has been paid to the explanation of the principles of reversibility. A copy of this booklet will be sent to anyone interested.

New Construction

PROPOSED WORK

Mass., Danvers—The Comn. of Mental Diseases, 36 State House, Boston, will receive bids until October 14 for installing a 1 story power plant at the State Hospital here. About $250,000. Noted July 20.

Mass., Wrentham—The Commonwealth of Massachusetts, c/o Kendall, Taylor & Co., 93 Federal St., Boston, has rejected all bids for a 1 story, 50 x 70 ft. cold storage building and a 40 x 90 ft. industrial building at the Wrentham State School, here; plans will be revised and new bids will be called. About $100,000. Noted April 27.

R. I., Providence—The City, Public Bldg. Dept., will soon award the contract for a 3 story school, including a steam heating system on Kenyon Ave. About $700,000.

N. Y., Buffalo—The National Lamp Co., c/o F. S. Terry, Nela Park, East Cleveland, O., plans to build a power plant here. About $200,000. George H. Johnson, Nela Park, East Cleveland, O., Archt.

N. Y., Buffalo—The State Hospital Comn., Capitol, Albany, received bids for an addition to the central heating plant at the Buffalo State Hospital here, from Morani & Gibbs, 608 Niagara Life Bldg., $162,300; J. W. Danforth Co., 70 Ellicott St., $168,-710; Geo. H. Drake, 218 Lexington Ave., $174,375. Noted August 31.

N. Y., Green Island (Troy P. O.)—The Ford Motor Co., Boulevard and Woodward St., Detroit, Mich., plans to build a power plant here, to develop 6,000 hp. About $2,000,000. Stone & Webster, 120 B'way, New York City, Engrs.

N. Y., Jamestown—The Dahlstrom Metallic Door Co. plans to install a 300 hp. synchronous motor generator set and make changes in the heating system. J. A. Westman is general manager.

N. Y., New York—The Bronx Co., 177th St. and Bronx River, plans to install steam turbines in generating plant.

N. Y., New York—The Dept. of Water Supply, Gas and Electricity received bids for furnishing, delivering and installing additional discharge lines at the 179th St. pumping station from the Melrose Constr. Co., 103 East 125th St., $14,000; John A. Greggory, $14,753; Henry E. Fox, 81 East 125th St., $15,700.

N. J., Pennington—The Peerless Insulated Wire & Cable Company is in the market for shafting, pulleys and hangers, to be used in connection with its new plant. Chas. E. Miller, Supt.

N. J., Ventnor City (Atlantic City P. O.)—The Common Council will receive bids until Oct. 25 for additions and alterations to waterworks including new building, boiler, pressure tanks, etc. W. I. Risley, Guarantee Trust Bldg., Atlantic City, Civil Engr.

Md., Baltimore—The Chizuk Amuno Congregation, c/o W. Levy, 2352 Eutaw Place, will soon award the contract for a 1 and 2 story, 85 x 115 ft. synagogue including a steam heating system at Eutaw Place and Chauncey Ave. About $400,000. J. E. Sherry, 409 Calvert Bldg., Archt.

Md., Baltimore—The Johns Hopkins Hospital will soon award the contract for a 7 story, 70 x 185 ft. hospital building addition at Wolfe and Monument Sts. A steam heating system will be installed in same. J. E. Sherry, 409 Calvert Bldg., Archt. and Engr.

Md., Baltimore—The United States Fidelity & Guaranty Co., Calvert and Redwood Sts., will receive bids until Oct. 21 for a 3 story, 40 x 113 ft. office building including steam heating system on Calvert and Mercer Sts. About $300,000. Wyatt & Nolting, 1012 Keyser Bldg., Archt., H. F. Doeleman, 507 North Charles St., Engr.

D. C., Washington—The Washington Ice Mfg. Co., 3327 K St., N. W., plans to build an ice plant on 23d and M Sts., N. W. About $200,000.

D. C., Washington—Bureau of Yards and Docks, Navy Dept., will receive bids until Oct. 15, for a 69 x 81 ft. power house at the Naval and Experimental Research Laboratory at Bellevue.

Fla., Jacksonville—The Secy. of the City Comn., Room 13, City Hall, will receive bids until October 15 for furnishing and delivering one 333 kva. oil cooled transformer 6,600-13,200 volts primary, 2,300 volts secondary, 60 cycles, 7,200 alternations, provided with four 2½ per cent full capacity taps in the 13,200-volt winding, or two 5 per cent taps in the 6,600-volt winding. Bidders are requested also to state allowance that will be made for three burned out 300 kva. General Electric water-cooled transformers, 60 cycles, 6,600 volts primary, 2,200 volts secondary.

Ga., Trion—The Trion Co., Inc., is planning to build a 1 story addition to its power plant. Jackson & Moreland, 387 Washington St., Boston, Mass., Engrs.

Ky., Covington—The City plans an election to vote on $250,000 bonds for the installation of a 10,000,000 gal. electric triple expansion pump for the municipal waterworks. J. M. Louk, Supt. Pub. Wks.

O., Cleveland—The Allen Theater Enterprises, Richmond E St., Toronto, Ontario, plans to build a power plant for a new theater and commercial building at Euclid Ave. and East 14th St., here.

O., Cleveland—The Broadway Savings & Trust Co., O. M. Stafford, Pres., East 55th St. and B'way, is having plans prepared for an 8 story, 80 x 150 ft. bank and office building, including a steam heating system. About $400,000. Walker & Weeks, 1900 Euclid Ave., Archt.

O., Cleveland—The Citizens' Savings & Trust Co., c/o Alvord Smith, East 9th St. and Euclid Ave., will soon award the contract for a 10 story bank and office building including steam heating system at East 101st St. and Euclid Ave. About 1,000,000. Walker & Weeks, 1900 Euclid Ave., Archt.

Ind., Marion—Hoggson Bros., Archts. and Engrs., 485 5th Ave., New York City, are preparing preliminary plans for a 1 story bank building including a steam heating system, here, for the First Natonal Bank About $300,000.

Ill., Chicago—The Chas. G. Stevens Co., 33 South Jefferson St., will soon award the contract for a warehouse, garage and power house on Western Ave. and 45th Place. About $75,000.

Wis., Camp Douglas—The Wisconsin National Guard is having plans prepared for a 45 x 50 ft. power and engine house and is in the market for boilers and engines. Henry Hengels, 425 East Water St., Milwaukee, Archt. and Engr.

Wis., Milwaukee—Backer & Pfaller, Archts., 216 West Water St., will soon award the contract for a 1 story, 90 x 150 ft. factory including motors, etc., on State St. for the Shope Brick Co., 216 West Water St.

Wis., Milwaukee—The Sewerage Comn. plans to build a boiler house on Jones Island. Six 500-600 hp. boilers will be installed. T. C. Hatton, City Hall, Engr.

Iowa., Fort Dodge—The Bd. Educ., c/o Paul Gustafson, Secy., will receive bids until Oct. 27, for a 3 story, 190 x 260 ft. high school including steam heating system. About $650,000. Wm. B. Ittner, Bd. of Trade Bldg., Archt.

Kan., Burlingame—The City is having plans prepared for a power plant. About $70,000. Black & Veatch, 701 Mutual Bldg., Kansas City, Mo., Engrs.

Kan., Wellington—The City is having plans prepared for electrical improvements to the light and water plant including installation of boiler, generator and turbine. About $60,000. Johnson & Benham, Kansas City, Mo., Engrs. Noted March 9.

Neb., Sidney—I. G. Graybill, Mayor, will receive bids until October 15, for remodeling present power plant and installing two 250-hp. boilers, engine, generator, etc. Noted March 9.

N. D., Mayville—Arthur Devor, Archt., 486 Endicott Bldg., St. Paul, Minn., plans to build a 1 story, 64 x 84 ft. power house. About $20,000. Owner's name withheld.

Mo., Webb City—The Rock Hill Pant & Cloth Co. is having plans prepared for a pant factory to consist of a 2 story, 61 x 150 ft. and a 3 story, 16 x 30 ft. building, and is in the market for a 250 hp. oil engine. About $150,000. Bucy, Niller Engr. Co., Joplin, Engr.

Tex., Austin—The University of Texas, Board of Regents, is having plans prepared for a 3 story, 70 x 200 ft. addition for the biology department, including additions to the present heating and power units. About $300,000. Geo. A. Endress, Littlefield Bldg., Archt.

Col., Denver—The Rocky Mountain Consistory No. 2, 16th and Grant Streets, is having plans prepared for a 6 story, 116 x 171 Masonic temple including steam heating and forced ventilatton system. Estimated cost $650,000 to $800,000. Gardner & Parry, 209 Guardian Trust Bldg., Engrs.

Ore., Burns—Louis C. Kelsey, Consult. Engr., Portland, has submitted estimates to the City Council, for the installation of the proposed municipal light and water plant. About $300,000. Noted June 22.

Ont., Queenston—The City plans to install five generators of 55,000 hp. each and other equipment in the proposed 160 x 600 ft. hydro-electric power house here. About $4,000,000.

Man., Winnipeg—The Government plans to expend $1,000,000 on hydro-electric developments in rural Manitoba. J. M. Leamy, Provinclal Power Comnr.

CONTRACTS AWARDED

Mass., Boston—The City has awarded the contract for furnishing and erecting two pumping plants, one to be located at Lincoln power station of the Boston Electric Ry. Co., Commercial St., and the other at Station 38, property of the Electric Illuminating Co., Atlantic Ave., to the Westinghouse Electric & Mfg. Co., 10 High St., at $174,469.

Mass., Wakefield—The Heywood Bros. & Wakefield Co., Gardner, have awarded the contract for a 1 story, 40 x 50 ft. boiler house. Cost, between $25,000 and $30,000. Noted Oct. 5.

N. Y., Brooklyn—The New York State Hospital Comn. has awarded the contract for a 2 story, 50 x 70 ft. addition to the laundry building at the Brooklyn State Hospital to the White-Johnson Co., 1133 B'way, New York City, at $450,000.

N. Y., New York—The A. Z. A. Realty Co., 31 East 27th St., will build a 12 story, 25 x 45 ft. office and showroom building including a steam heating system at 415 Lexington Ave. About $600,000. Work will be done by day labor.

N. Y., New York—The Church of Christ Scientist, c/o B. E. Miller, Archt., 477 5th Ave., will build a 75 x 95 ft. church including a steam heating system on Anthony Ave. About $300,000. Work will be done by day labor.

N. Y., New York—The Plaza Hotel, 58th St., has awarded the contract for alterations and addition to hotel including a steam heating system to Geo. A. Fuller, 175 5th Ave. About $250,000.

N. Y., New York—The Union Indemnity Co., New Orleans, La., has awarded the contract for an 8 story office building including a steam heating system at 96 Maiden Lane, here, to A. C. Voight, Grand Central Terminal Bldg., New York City. About $350,000.

N. J., New Brunswick—W. Reade, 112 West 34th St., New York City, has awarded the contract for a 1 story, 100 x 235 ft. theater building on Livingston Ave., to C. Brown, Campbell Ave., Long Branch, N. J., at $500,000. A steam heating system will be installed in same.

Pa., Philadelphia—The Reyburn Mfg. Co., 23rd and Allegheny Sts., has awarded the contract for a warehouse, power house, etc., to Wm. Steele & Sons Co., 16th and Arch Sts.

La., Bogalusa—The Great Southern Lumber Co. has awarded the contract for an addition to paper mill plant including a steam heating system, to Stone & Webster, 120 B'way, New York City, at $250,000.

La., New Orleans—The New Orleans Gas Light Co., Baronne and Common Sts., has awarded the contract for two new generators to the Western Gas Constr. Co., Buchanan, Holt and Winter Streets, Fort Wayne, Ind.

La., New Orleans—The Supervising Archt., Treasury Dept., Washington, D. C., has awarded the contract for a refrigerating machine to be installed in the marine hospital here, to the Wm. Leibe Refrigerator Mfg. Co., New Orleans, La., at $1,990.50.

Ill., Chicago—The Chicago & Alton R.R., 608 South Dearborn St., has awarded the contract for a warehouse including a steam heating system to Dwight P. Robinson, 125 East 46th St., New York City, at $1,000,000.

Wis., Oconomowoc—The Oconomowoc Fuel Co. has awarded the contract for furnishing coal conveying and handling machinery to be used in connection with new coal storage sheds, etc., to the Northern Conveyor & Mfg. Co., 3027 Walnut St., Milwaukee. Est. cost $25,000.

Tex., El Paso—The Home Mission Board, Southern Baptist Conference, Atlanta, Ga., has awarded the contract for 2 ward buildings, power house, etc., here, to the C. W. Hedrick Constr. Co., Southwestern Life Bldg., Dallas, at $300,000.

Ore., Portland—The Public Dock Comn. has awarded the contract for ten 100 hp. motors and compensators for the new 15,000 ton drydock, to the Westinghouse Electric Manufacturing Co., Union Bank Bldg., Pittsburgh, Pa., at $29,040.

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